Outcomes of Chandelier-Assisted Segmental Scleral Buckling Compared to Conventional Scleral Buckling for Primary Rhegmatogenous Retinal Detachment: A comparative retrospective study

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SUMMARY

Purpose: To compare the anatomical and functional outcomes, surgical duration, and complication rates between chandelier-assisted segmental scleral buckling (SB) and conventional SB in the treatment of primary rhegmatogenous retinal detachment (RRD).

Material and Methods: This retrospective comparative study included 19 phakic patients with primary RRD who underwent either conventional SB (Group 1, n = 9) or chandelier-assisted segmental SB (Group 2, n = 10). Patients were selected based on specific inclusion criteria including presence of anterior retinal breaks and PVR ≤ Grade C1. Group 1 underwent standard 360-degree SB with indirect ophthalmoscopy, while Group 2 underwent segmental SB with limited peritomy and chandelier-assisted wide-angle visualization under a surgical microscope. Primary outcomes included best-corrected visual acuity (BCVA) and anatomical reattachment at 1-year follow-up. Secondary outcomes included surgical duration and epiretinal membrane (ERM) formation.

Results: Both groups demonstrate successful retinal reattachment in all cases and significant improvement in BCVA at one year, with no statistically significant intergroup difference. Mean surgical duration was significantly shorter in the chandelier-assisted group (35.1 ±21.2 minutes) compared to the conventional group (70.2 ±23.2 minutes, $p < 0.05$). ERM formation was not significantly different between the groups, and no major intraoperative complications were noted.

Conclusion: Chandelier-assisted segmental SB is a safe and effective technique for managing selected cases of primary RRD. It offers comparable anatomical and visual outcomes to conventional SB, with the added advantages of reduced surgical time and improved intraoperative visualization.

Key words: Chandelier-Assisted, Segmental Scleral Buckling, Conventional Scleral Buckling, RRD, Outcomes

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INTRODUCTION

Rhegmatogenous retinal detachment (RRD) is a vision-threatening condition characterized by the separation of the neurosensory retina from the underlying retinal pigment epithelium due to one or more retinal breaks. Prompt surgical intervention is essential to prevent permanent vision loss. The primary surgical options for managing RRD include scleral buckling (SB), pars plana vitrectomy (PPV), and pneumatic retinopexy (PR) [1,2]. Introduced in the 1950s, scleral buckling remains a well-established and effective method, particularly for uncomplicated phakic RRD. Despite its proven efficacy, the use of SB has decreased in favor of PPV, largely due to the technical challenges of traditional SB techniques and advancements in vitrectomy instrumentation.

Conventional SB surgery typically involves performing a full 360-degree peritomy and placing an encircling element along with a silicone tire. Indirect ophthalmoscopy is used for retinal visualization, with a handheld magnifying lens aiding in the identification and treatment of retinal breaks [3]. However, this approach poses challenges, especially for less experienced surgeons, as it requires navigating a small, inverted image, which may compromise accurate visualization of vitreoretinal pathologies and increase the risk of missing peripheral breaks, particularly when media clarity is reduced. Additionally, surgical time is prolonged as the surgeon must repeatedly put on and remove the indirect ophthalmoscope, a process that usually requires assistance from a surgical assistant [4].

Among the various SB techniques, segmental scleral buckle with limited peritomy has emerged as a refined approach [5]. Unlike the traditional 360-degree peritomy, where the conjunctiva is circumferentially incised, this technique involves a more localized peritomy restricted to the quadrant where the buckle is placed, with a slight extension to facilitate muscle tagging. This targeted approach aims to reattach the retina by providing localized support at the site of the retinal break while minimizing the complications associated with more extensive procedures.

In recent years, the integration of chandelier endoillumination into segmental SB surgery has gained popularity, drawing inspiration from PPV techniques [6]. This method involves inserting a chandelier light source through a small sclerotomy, providing wide-angled, magnified, and upright visualization through noncontact lens systems under a surgical microscope.

Our study aimed to compare the outcomes of chandelier-assisted segmental buckling with the conventional scleral buckling in primary rhegmatogenous retinal detachment.

MATERIAL AND METHODS

This is retrospective study conducted at our eye hospital, in accordance with the ethical principles outlined in the Declaration of Helsinki for research involving human subjects. Written informed consent was obtained from each participant after a comprehensive explanation of the invasive procedures involved. The study protocol received approval from the institutional review board.

Patient Selection

The study included patients who underwent scleral buckle surgery for RRD. Inclusion criteria comprised phakic patients with primary RRD associated with pre-equatorial retinal breaks or retinal dialysis, as well as patients with proliferative vitreoretinopathy (PVR) up to grade C1, as defined by the updated Retina Society classification [7].

Exclusion criteria encompassed patients with a history of prior ocular surgery, posterior or giant retinal breaks, breaks located in more than two quadrants, macular holes, or significant media opacity, such as dense cataract or vitreous hemorrhage. Additionally, patients with concurrent ocular conditions, including diabetic retinopathy, retinal dystrophies, age-related macular degeneration, uveitis, or intraocular tumors, were excluded. Cases with a follow-up period of less than six months after scleral buckle surgery were also excluded from the study.

Study Groups

The study population was categorized into two groups based on the surgical technique employed.

- Group 1 (Conventional SB): Patients underwent traditional scleral buckle surgery using indirect ophthalmoscopy.
- Group 2 (Chandelier-Assisted Segmental SB): Patients underwent segmental scleral buckle surgery utilizing wide-angled visualization with chandelier endo-illumination. The choice of surgical technique was not influenced by any preoperative clinical characteristics.

A total of 19 patients were included in the study, with 9 patients in Group 1 (Conventional SB) and 10 patients in Group 2 (Chandelier-Assisted Segmental SB).

Preoperative Assessment

All patients underwent a comprehensive ophthalmic evaluation, including a thorough slit-lamp examination of the anterior segment and a detailed fundoscopic examination using indirect ophthalmoscopy. Relevant demographic and ophthalmic information such as age, gender, the affected eye, best-corrected visual acuity (BCVA) in the affected eye, intraocular pressure (IOP), extent and duration of retinal detachment, location of retinal break, and macular status (on/off) were recorded. A detailed colored retinal mapping scheme was created for surgical planning.

Surgical time to complete the surgery was recorded from the operation theatre records.

Surgical Technique

All surgeries were performed by a highly skilled retinal surgeon (A.M.) under local anesthesia. The operative site was meticulously prepared using a 5% povidone-iodine solution, followed by sterile draping. A surgical microscope was used to enhance visualization throughout the procedure.

Group 1: Conventional Scleral Buckle Surgery

A 360° perilimbal peritomy was performed using Westcott scissors to expose the sclera. The rectus muscles were secured with sling sutures (4-0 silk) to maintain adequate exposure. Visualization of retinal tears was achieved using indirect ophthalmoscopy with a 20 D condensing lens. Both a silicone tire and an encircling element were utilized to achieve the desired buckling effect. The buckling element was sutured to the sclera using a 5-0 Ethibond suture in a mattress technique to ensure proper indentation. The conjunctiva was closed with a 7-0 polyglactin suture.

Group 2: Chandelier-Assisted Segmental SB Surgery

In this group, a limited peritomy was performed according to the extent of the buckle placement (Figure 1A). For retinal breaks present in one quadrant, two rectus muscles were bridled, while three muscles were bridled when breaks were located in two quadrants. A sclerotomy was created using a 25-gauge trocar placed 4 mm posterior to the limbus, positioned 90° to 180° from the retinal tear. A noncontact wide-field visualization system (Resight 700) was used following the insertion of a single-fiber

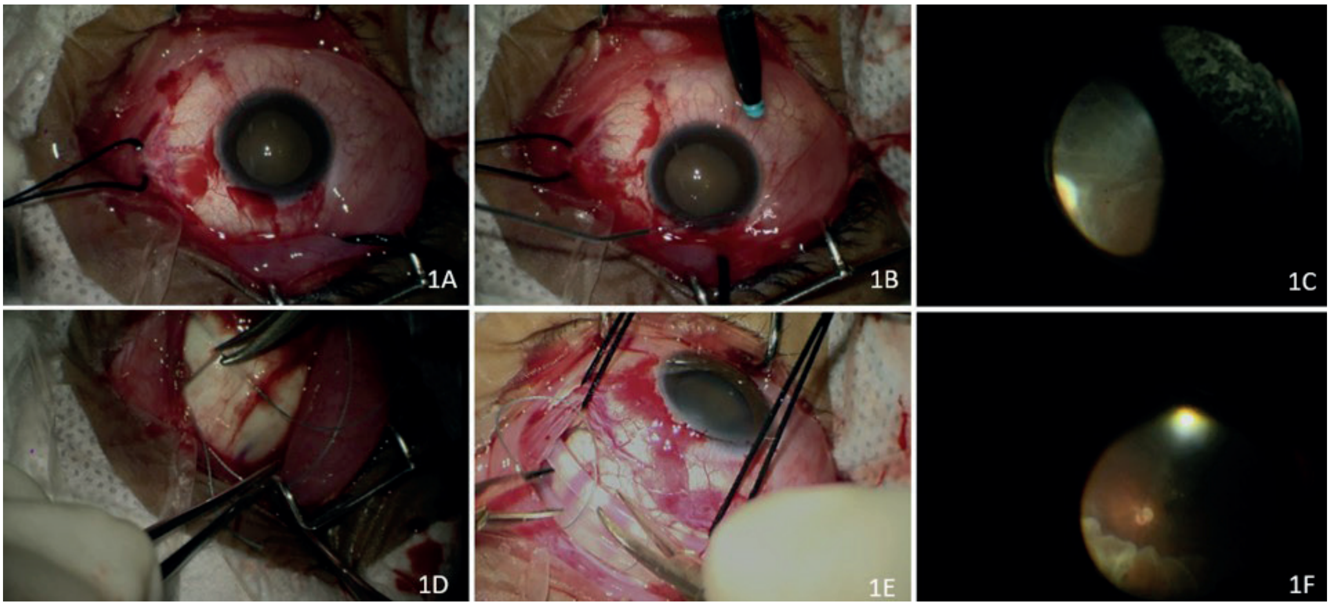

Figure 1. Demonstration of the steps in Chandelier assisted segmental scleral buckling. (**A**) limited peritomy performed corresponding to the extent of buckle placement, (**B**) a 25-gauge trocar inserted 4 mm posterior to the limbus, positioned 90° to 180° from the retinal tear, followed by insertion of a 25-gauge chandelier probe under noncontact wide-field visualization (Resight 700), (**C**) cryopexy applied to identified retinal breaks under chandelier-assisted visualization, (**D–E**) segmental silicone tire sutured to the sclera with 5-0 ethibond in a mattress pattern, (**F**) buckle indentation and break-buckle alignment confirmed using chandelier illumination

chandelier probe (25-gauge, Alcon Laboratories Inc., Fort Worth, TX). Figure 1B|.

The retinal tears were meticulously identified, and cryopexy was applied to the affected areas (Figure 1C). Unlike Group 1, only the silicone tire was used in Group 2, without the encircling element. The buckle was sutured to the sclera using a 5-0 ethibond suture in a mattress pattern to ensure stability (Figure 1D–1E). Buckle indentation and adequate break buckle relationship was confirmed using chandelier light (Figure 1F). The sclerotomy site was closed with a 7-0 polyglactin suture. The conjunctiva was closed with a 7-0 polyglactin suture.

Subretinal fluid drainage was done in both the groups, only in cases with bullous retinal detachment or old retinal detachment.

Postoperative Care and Follow-Up

Postoperative care included the administration of topical antibiotics, steroids, and cycloplegics to minimize inflammation and prevent infection. Follow-up examinations involved assessing BCVA, IOP, anterior segment status, and a dilated posterior segment evaluation. These assessments were performed at regular intervals to monitor surgical outcomes and detect any complications.

The primary outcome measures were functional outcomes, assessed by final BCVA, and anatomical success, defined as primary retinal reattachment at 1-year follow-up. Secondary outcome measures included surgical duration and the incidence of epiretinal membrane (ERM) formation during the follow-up period.

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., New York, USA). Descriptive statistics were expressed as mean ± standard deviation. Categorical variables were analyzed using the Chi-square test. The normality of the data distribution was assessed using the one-sample Kolmogorov–Smirnov test. For nonparametric variables, the Mann–Whitney U test was applied. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of patients was 32.1 ±15.2 years in Group 1 and 29.2 ± 10.6 years in Group 2. Baseline BCVA was 0.9 ±0.6 logMAR in Group 1 and 0.5 ±0.5 logMAR in Group 2. Mean IOP was 15.4 ±4.3 mmHg in Group 1 and 16.6 ±5.3 mmHg in Group 2.

In terms of the extent of retinal detachment, Group 1 included four patients with inferior detachment, three with subtotal, and two with total detachment. Group 2 included four patients with inferior detachment, three with superior, two with subtotal, and one with total detachment. Retinal breaks were distributed across quadrants as follows: superotemporal (Group 1: 11%, Group 2: 33%), superonasal (Group 1: 11.1%, Group 2: 20%), inferotemporal (Group 1: 33.3%, Group 2: 30%), and inferonasal (Group 1: 44.4%, Group 2: 20%).

Macular detachment was present in 6 of 9 patients in Group 1 and in 5 of 10 patients in Group 2. The mean baseline refractive spherical equivalent (MRSE) was -5.5 ±5.6 in Group 1 and -6.3 ±5.6 in Group 2. Table 1 highlights baseline demographic profile and ocular parameters in Group 1 and Group 2.

Table 1. Highlights baseline demographic profile and ocular parameters in Group 1 and Group 2

	Conventional SB (Group 1)	Chandelier assisted segmental SB (Group 2)	P value
Number of patients	9	10	0.6
Mean age	32.1 ±15.2	29.2 ±10.6	0.2
Male: Female	2:1	3:2	0.3
Baseline BCVA	0.9 ±0.6	0.5 ±0.5	0.1
Extent of retinal detachment			0.4
Inferior	4	4	
Superior	0	3	
Subtotal	3	2	
Total	2	1	
Location of primary break			0.2
ST quadrant	1	3	
SN quadrant	1	2	
IT quadrant	3	3	
IN quadrant	4	2	
Macula status			0.1
On	3	5	
Off	6	5	
Baseline MRSE	-5.5 ±5.6	-6.3 ±5.6	0.2

SB – scleral buckling, BCVA – best corrected visual acuity, ST – supero-temporal, SN – supero-nasal, IT – infero-temporal, IN – infero-nasal, MRSE – mean refractive spherical equivalent

Surgically, all Group 1 patients underwent a 360-degree encircling element combined with a silicone tire. In Group 2, only a segmental silicone tire was used, without an encircling band. Among Group 2 patients, 7 had the buckle placed in a single quadrant, and 3 had it placed in two quadrants.

The mean surgical time was significantly shorter in Group 2 (35.1 ±21.2 minutes) compared to Group 1 (70.2 ±23.2 minutes). Both groups showed significant improvement in BCVA at final follow-up. Group 1 improved to 0.3 ±0.3 logMAR, while Group 2 improved to 0.2 ±0.2 logMAR; however, the intergroup difference was not statistically significant.

Final postoperative MRSE was -6.0 ±4.5 in Group 1 and -6.5 ±4.5 in Group 2, with no significant change from baseline in either group. At 1-year follow-up, all eyes in both groups achieved successful retinal reattachment. No patients in Group 1 developed ERM, while one patient in Group 2 developed grade 0 ERM with preserved foveal contour.

DISCUSSION

SB remains a time-tested and effective surgical modality for managing RRD, especially in phakic eyes with anterior breaks. Despite its high anatomical success rates, the usage of SB has declined in recent decades, largely due to the technical complexity of the conventional approach, which often poses a steep learning curve for younger vitreoretinal surgeons [3]. The traditional method, involving a 360-degree peritomy, encircling element placement, and reliance on indirect ophthalmoscopy, can be time-consuming and ergonomically challenging.

Studies indicates a declining trend for scleral buckling surgery in RRDs since 2005, with surgeons preferring pars plana vitrectomy surgery for RRD repair [8]. This declining trend is often attributed to the technical challenges associated with traditional SB techniques, particularly the limited visualization offered by indirect ophthalmoscopy during surgery.

Poor visualization can hinder the accurate identification and localization of retinal breaks, contributing to a steeper learning curve and increased intraoperative complexity. Consequently, this has led to a shift toward techniques that offer improved intraoperative visualization using wide-angle viewing systems and chandelier-assisted illumination [9].

Our study adds to the growing body of evidence supporting the utility of chandelier assisted illumination to perform minimally invasive limited peritomy SB for rhegmatogenous retinal detachment.

The primary outcome of our study demonstrates that both chandelier-assisted segmental SB and conventional SB yield comparable anatomical and functional outcomes, including retinal reattachment rates and improvements in BCVA. All eyes in both groups achieved successful anatomical reattachment at one year. Similarly, postoperative visual acuity improved significantly in both groups, with no statistically significant difference between them.

A significant advantage of the chandelier-assisted approach was the marked reduction in surgical time. The mean surgical duration in the chandelier group was nearly half that of the conventional SB group (35.1 ±21.2 minutes vs. 70.2 ±23.2 minutes). These findings align with previous studies reporting shorter surgical times with chandelier-assisted SB compared to traditional techniques [10,11].

Several factors likely contribute to this reduction. The use of a wide-angle, non-contact viewing system combined with chandelier illumination provides an upright and expansive view of the retinal periphery. This enables more precise localization of retinal breaks and more effective application of cryopexy [6]. In contrast, conventional indirect ophthalmoscopy is associated with limitations such as image inversion, a narrower field of view, and frequent instrument switching-challenges that are especially pronounced for less experienced surgeons.

It could be argued that with increased surgical experience and improved proficiency in peripheral retinal examination, the time required for conventional SB may approach that of chandelier-assisted procedures [12]. However, our technique also included segmental buckling with a limited peritomy, which further reduced surgical time by simplifying the procedure and eliminating several steps required in traditional SB.

Direct intraoperative visualization during subretinal fluid drainage through the microscope is another benefit of this approach. It eliminates the risks associated with blind drainage, thereby improving accuracy and safety during surgery [13].

Importantly, the chandelier-assisted technique is also more ergonomic and surgeon-friendly, particularly for trainees and early-career surgeons [6]. Performing SB under direct microscope visualization enhances hand–eye coordination and offers a more intuitive learning curve. Additionally, the upright view allows multiple observers to simultaneously view the surgical field, significantly benefiting surgical teaching and supervision.

The segmental nature of the buckle and the limited peritomy used in the chandelier group offer further advantages. By avoiding a 360-degree encircling element, the risks of inducing diplopia, postoperative discomfort, choroidal ischemia and refractive changes are minimized [14,15]. This localized approach is especially effective in eyes where retinal breaks are confined to one or two quadrants – as was the case in most eyes treated with chandelier-assisted SB in our series.

Although concerns regarding potential chandelier-associated complications – such as iatrogenic retinal breaks, lens touch, or endophthalmitis – have been raised in the literature, we observed no such events in our cohort [6]. This is likely due to our use of 25-gauge chandelier probes with valved trocars, which help maintain intraocular stability and reduce the risk of globe deformation and intraoperative trauma.

The literature presents conflicting data on the incidence of ERM formation following chandelier-assisted SB [12]. In our study, there was no significant difference in ERM formation between the chandelier and conventional groups. A recent meta-analysis recommended routine suturing of sclerotomy sites to reduce the risk of ERM. In our series, all sclerotomies were sutured, which may have contributed to the absence of ERM in patients who underwent chandelier-assisted SB.

Limitations of this study include its retrospective nature and the relatively small sample size, which may limit the generalizability of the findings. Furthermore, surgeon bias cannot be entirely ruled out, as all surgeries were performed by a single experienced surgeon. However, this also ensures uniformity in surgical technique and minimizes inter-operator variability.

In conclusion, chandelier-assisted segmental scleral buckling is a safe, efficient, and effective technique for managing localized RRD. While maintaining comparable anatomical and visual outcomes to conventional SB, it offers significant reductions in operative time and improved intraoperative visualization. As vitreoretinal surgery continues to evolve, the integration of endoillumination in SB may help preserve this valuable technique by making it more accessible, especially for younger surgeons.

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