Original Article

Chandelier-assisted scleral buckle surgery – contact versus non-contact wide-angle viewing system (CAB-CNV): A retrospective, multicenter, clinical study

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Purpose: To investigate and compare the anatomic and functional outcomes of chandelier-assisted scleral buckling (CASB) surgery using contact versus non-contact lens-based wide-angle viewing systems (WAVSs) in rhegmatogenous retinal detachment (RRD) patients. **Methods:** This was a retrospective, multicenter study evaluating the anatomic (reattachment rate) and visual acuity (VA) outcomes at 6 months post-CASB for primary RRD. **Results:** Forty-seven RRD patients underwent CASB with a non-contact WAVS (Group C1) and 90 with a contact lens WAVS (Group C2). Preoperative parameters including myopia, macula-off RRD, posterior vitreous detachment, number of retinal breaks, and retinal dialysis as the etiology of RRD did not differ significantly between the two groups. The outcomes of retinal attachment (85.11% of C1 patients and 76.67% of C2 patients, $P = 0.34$) and final visual outcome (VA ≥6/12: C1 = 61.7%; C2 = 46.67%, $P = 0.13$) were also comparable. Furthermore, no significant difference in postoperative complications such as cataracts, glaucoma, infection, buckle exposure, and buckle failure was observed. Finally, both groups were comparable in terms of re-detachment rates (10.64% in C1 and 23.33% in C2, $P = 0.11$). **Conclusion:** The two WAVS approaches used in CASB surgery have comparable surgical and functional outcomes and postoperative complications. The operating surgeon can freely choose between these viewing platforms during the contemporary scleral bucking (SB) surgery without impacting the outcome.

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Rhegmatogenous retinal detachment (RRD) is an ocular emergency that carries the risk of causing permanent vision loss.[1] The cardinal principle of managing RRD is to identify the retinal breaks and secure them with laser photocoagulation or cryopexy, along with relieving the retina from associated vitreous traction.[2] The surgical management of RRD has evolved throughout the years, ranging from pneumatic retinopexy and scleral buckle (SB) surgery to pars plana vitrectomy (PPV) and vitrectomy with SB surgery.[3] SB has significant advantages over vitrectomy in specific instances, such as young patients who have lattice degeneration and an attached posterior hyaloid, phakic patients who have increased risks of post-vitrectomy cataract formation, children for whom postoperative positioning can be difficult, and phakic patients who have inferior detachment.[3,4] In the first and only prospective randomized "Scleral Buckling versus Primary Vitrectomy in Rhegmatogenous Retinal Detachment" (SPR) study, the outcomes demonstrated an obvious advantage of SB in terms of improving best corrected visual acuity (BCVA) for phakic patients.[5] Despite these evident advantages, SB has gradually lost popularity due to a steeper learning curve, longer operating time, neck and back pain among surgeons, and, most importantly, tremendous progress in the types of equipment, machinery, and wide-angle viewing system (WAVS) in vitrectomy compared to the indirect ophthalmoscopy-based viewing system used in SB surgery.

The key to a successful SB surgery is the exact localization of the retinal breaks to ensure the height and proper positioning of SB. However, traditional SB using an indirect ophthalmoscope (IO) is inconvenient due to issues such as inverted image creation, difficult visualization in poor pupillary dilation and hazy media, and lack of view to the assisting surgeon unless it is a video-assisted IO. Therefore, using the right viewing system is crucial for successful surgery along with adequacy of training for the assistant. Recent investigations have established the advantages of chandelier-assisted SB (CASB) with both non-contact and contact – two types of WAVS – over regular SB with an IO.[6-9] The use of WAVS eliminates the need for an IO, which could reduce the number of spinal disorders that are widespread among retina surgeons today. The attached camera does a

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wonderful job of capturing the view via the microscope, making it a useful teaching tool for trainee fellows and leading to more accurate records.[2] Recently, heads-up SB surgery has also been described employing a chandelier endoilluminator to perform the procedure.[10] All of these are reviving the attention of retina surgeons toward SB surgery, who previously had a low threshold for PPV in difficult-to-see breaks.

In 2012, Aras *et al*.[6] introduced the idea of CASB with a non-contact wide-field viewing system. Subsequent studies further supported the value of CASB when used in conjunction with a wide-field, non-contact viewing system.[11] On the other hand, contact wide-angle lens-aided CASB has also shown excellent visualization in RRD treatment, with anatomic and functional gains comparable to those obtained by surgery using an IO in RRD patients.[9,10,12,13] As there is currently insufficient data available to compare the efficacy of contact and non-contact WAVS, the decision between the two is left to the surgeon's personal preference. Furthermore, no trials have been conducted to compare them for CASB surgery. Through this observational study, we aimed to address this by comparing and evaluating the anatomic and functional outcomes of CASB surgery using a contact versus non-contact WAVS (CAB-CNV study).

Methods

This was a retrospective observational study conducted at two tertiary care centers in India between January 1, 2016, and July 31, 2022. The study was conducted in accordance with the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board at two tertiary care centers in India. Written informed consent was obtained from each patient.

Study population

Patients with primary RRD with pre-equatorial retinal breaks (<90°) and/or retinal dialysis and proliferative vitreoretinopathy (PVR) up to Grade C1 were included in the study. Patients with media opacity, vitreous hemorrhage, posterior or giant breaks, macular holes, previous retinal detachment (RD) surgery or vitrectomy, PVR grade > C1, and any other ocular pathologies were excluded from the study.

Design

At the first center (C1), 47 RRD patients underwent CASB with a non-contact WAVS (RESIGHT®; Carl Zeiss Meditec AG, Jena, Germany). At the second center (C2), 90 RRD patients underwent CASB with a contact lens WAVS (Mini Quad®; Volk, Mentor, OH, USA). All patients underwent comprehensive evaluation including BCVA assessment using Snellen's visual acuity (VA) chart, intraocular pressure (IOP) measurement by Goldmann applanation tonometer, and anterior segment evaluation with slit-lamp biomicroscope. In addition, fundus examination with slit-lamp biomicroscopy and IO was performed to evaluate the extent of RD, the presence of any predisposing pathologic features in the peripheral retina, PVR grading, signs of myopic degeneration, and to find retinal breaks, determining their location, type, and number. A detailed history of coincidental and past systemic and ocular pathologies and procedures was elucidated.

At each center, the surgeries were performed by a single experienced vitreoretinal surgeon (C1: AK; C2: MN). Both the operating surgeons have completed fellowships specializing in vitreoretinal surgeries, and they have similar degrees of professional experience (AK: 20 years, MN: 20 years). All surgeries were transmitted in real time to the viewing monitor within the operation theater (OT) for visibility to the surgical team, and the entire procedure was recorded for teaching and training purposes. The surgical steps have been summarized in Table 1.

The postoperative evaluation included BCVA, IOP, and anterior and posterior segment assessments. A 6-month postoperative period was used for the final comparison with the preoperative data, which included assessment for BCVA and anatomic retinal reattachment.

Statistical analysis

The Statistical analysis was performed by statistical package R version 3.5.3. Categorical variables are expressed as No. (%), and continuous variables are expressed as median (interquartile range [IQR]). The statistical tools used in this study are Pearson's Chi-squared test, Fischer's exact test or count data, and Wilcoxon rank sum test. P value < 0.05 was considered statistically significant.

Results

Study population

The baseline features of the patients of the two treatment groups are presented in Table 2. Patients at C2 were significantly younger than those in C1 (P = 0.00035). Myopia was the most prevalent risk factor in both groups, accounting for 74.47% of patients at C1 and 63.33% of patients at C2. In terms of lens status, C1 had significantly more pseudophakics (P = 0.02), while C2 had significantly more patients with clear lens (P = 0.012). C1 patients had 51.06% macula-on RRD and 48.93% macula-off RRD, while C2 patients had 33.33% macula-on RRD and 66.66% macula-off RRD. In terms of preoperative macular status, there was no significant difference between the two groups (P = 0.06). The number of retinal breaks in the patients did not significantly differ between the two groups (P = 0.89). Average number of retinal breaks detected in C1 was 1.40 and in C2 was 1.43, with a single break being detected in 63.83% of C1 patients and 61.11% of C2 patients, two breaks detected in 19.15% of C1 patients and 17.78% of C2 patients, and three or more breaks detected in 12.77% of C1 patients and 15.56% of C2 patients.

Surgical outcomes

At 6 months, successful retinal reattachment was observed in 85.11% of C1 patients and 76.67% of C2 patients, with no significant difference between the two groups (P = 0.35). Average number of missed breaks in group C1 was 0.07 and in group C2 was 0.08, with no significant difference between the two groups (P = 0.89). There was no statistically significant difference between the groups in terms of final BCVA (P = 0.14), with 61.7% of C1 patients and 46.67% of C2 patients achieving a BCVA of ≥ 6/12 (Snellen's acuity) and 38.3% of C1 patients and 53.33% of C2 patients having a BCVA of < 6/12, respectively. The treatment outcomes in two study groups have been presented in Table 3.

Postoperative complications

Buckle failure occurred in 14.89% of C1 and 23.33% of C2, with no statistically significant difference between the two groups (P = 0.35). An epiretinal membrane (ERM) formed in (five out of 47) 10.6% of the eyes in group C1 and (11 out of 90)

Table 1: Summary of the surgical steps at both the centers

Operating technique	Center 1	Center 2
Viewing system	Non-contact wide-field (RESIGHT®; Carl Zeiss Meditec AG, Jena, Germany)	Contact wide field (Mini Quad®; Volk, Mentor, OH, USA)
Anesthesia	Peribulbar (lignocaine+bupivacaine); general anesthesia	General anesthesia
Asepsis and antisepsis	10% Povidone-iodine (periocular area); 5% povidone-iodine (eyedrops)	10% Povidone-iodine (periocular area); 5% povidone-iodine (eyedrops)
Draping	Disposable sterile drapes	Disposable sterile drapes
Peritomy and isolation of rectus muscles	360° conjunctival peritomy; isolation of all recti muscles and placement of traction sutures	360° conjunctival peritomy; isolation of all recti muscles and placement of traction sutures
Sclerotomy	25-gauge EdgePlus trocar (Alcon) with a valved cannula at 3.5 and 4 mm posterior to the limbus for pseudophakic and phakic patients, respectively, preferably located 180° from the retinal tear	25-gauge EdgePlus trocar (Alcon) with a valved cannula at 3.5 and 4 mm posterior to the limbus for pseudophakic and phakic patients, respectively, preferably located 180° from the retinal tear
Illumination technique	Chandelier endoilluminator with the fiberoptic connected to a Constellation (xenon) vitrectomy system (Alcon Laboratories, Inc.). Illumination level range 25–30 lm	Chandelier endoilluminator with the fiberoptic connected to a Constellation (xenon) vitrectomy system (Alcon Laboratories, Inc.) Illumination level range 25–30 lm
Examination of the fundus and localization of the breaks	Non-contact wide-field viewing system (and chandelier endoilluminator) with indentation to localize breaks	Contact wide-field viewing system (and chandelier endoilluminator) with indentation to localize breaks
Management of retinal breaks and suspicious areas	Cryopexy	Cryopexy
Exoplant	Silicone sponge (511; LABTICIAN Ophthalmics, Inc., Oakville, Ontario, Canada) as a segmental or encirclage buckle	Silicone sponge (506; LABTICIAN Ophthalmics, Inc., Oakville, Ontario, Canada) as a segmental or encirclage buckle
Positioning of exoplant	Passing of silicone sponge underneath the rectus muscles and preplacement of Ethibond 5-0	Passing of silicone sponge underneath the rectus muscles and preplacement of Ethibond/Mersilene 5-0
Subretinal fluid drainage	Not done	Full drainage through a sclerotomy with a 24-gauge needle after diathermy to the sclerotomy site
Examination of the retina and scleral buckle indentation effect on the sclera	With non-contact wide-field viewing system and chandelier endoilluminator (before and after scleral buckle fixation)	With contact wide-field viewing system with chandelier endoilluminator (during subretinal fluid drainage, before and after scleral buckle fixation)
Scleral buckle fixation	Tying of preplaced Ethibond/Mersilene 5-0 sutures	Tying of preplaced Ethibond/Mersilene 5-0 sutures
Sclerotomy site closure	Vicryl 8-0	Vicryl 8-0
Closure of conjunctival peritomy	Vicryl 8-0	Vicryl 8-0
Aftercare	Postoperative antibiotic and steroid eyedrops	Postoperative antibiotic and steroid eyedrops

12.2% of the eyes in group C2 over the 6-month postoperative follow-up period ($P = 0.78$). The other complications included the development of glaucoma ($P = 0.71$) and cataracts ($P = 0.3$), buckle exposure ($P = 0.34$), and buckle infection ($P = 1$). None of these differences in complication rates between the two groups reached statistical significance. The comparison of the postoperative complications between the two study groups can be found in Table 4.

Discussion

There has been a transition in recent years away from SB surgery to vitrectomy as the preferred technique for the management of RD. This pattern may be attributable, at least in part, to the developments that have been made in vitrectomy surgery, mainly concerning its instrumentation and the operating systems. The introduction of smaller, more specialized instruments and the development of more efficient surgical techniques have made vitrectomy an attractive option for treating RD. The use of vitrectomy has been further encouraged by the fact that, when compared to the traditional SB surgery, the use of WAVS provides a panoramic view of the fundus, allowing for improved accuracy in localizing and treating all retinal breaks.[2,3] Visualization of the fundus during traditional SB surgery, on the other hand, necessitates the use of an IO, which creates an image that is upside down and very small, making it difficult to locate breaks. Furthermore, the image created by an IO is not easily shared with other trainees and assistants, and a complex repeated exchange of IO and condensing lens may be required to visualize the fundus after each step. As a result, visualization of the fundus during traditional SB surgery can be challenging and time-consuming. To overcome these challenges, a novel technique of CASB has been developed, which utilizes WAVS to visualize the surgical site.[6-9] For using this method, IO is not required and the fundus can be directly visualized without having to switch out the condensing lens and IO. This method of CASB simplifies the process significantly, providing a more efficient and less time-consuming alternative to traditional SB surgery.

Table 2: Baseline characteristics of the study population

	Group C1 (*n*=47)	Group C2 (*n*=90)	*P*
Sex (male)	33 (70.21%)	69 (76.67%)	0.5379
Median (IQR) age in years	29 (55–24)	24 (34–17)	0.00035
Presenting complaints (OD/OS)			
OD	29 (61.7%)	56 (62.22%)	1
OS	18 (38.3%)	34 (37.78%)	
Myopia	35 (74.47%)	57 (63.33%)	0.2603
Cataract	4 (8.51%)	3 (3.33%)	0.2315
Dialysis	2 (4.26%)	8 (8.89%)	0.4936
Clear lens	37 (77.72%)	85 (94.44%)	0.01209
No. of retinal breaks (hole)			
1	30 (63.83%)	55 (61.11%)	0.8928
2	9 (19.15%)	16 (17.78%)	
≥3	6 (12.77%)	14 (15.56%)	
Macula status			
On	24 (51.06%)	30 (33.33%)	0.06695
Off	23 (48.94%)	60 (66.67%)	

IQR=interquartile range

Table 3: Treatment outcomes of the study population

	Group C1 (*n*=47)	Group C2 (*n*=90)	*P*
Retina attached	40 (85.11%)	69 (76.67%)	0.3473
VA (6 months follow-up)			
VA <6/12	18 (38.3%)	48 (53.33%)	0.1357
VA ≥6/12	29 (61.7%)	42 (46.67%)	

VA=visual acuity

Table 4: Postoperative complications of the study population

	Group C1 (*n*=47)	Group C2 (*n*=90)	*P*
Glaucoma	2 (4.26%)	6 (6.67%)	0.7149
Cataract	0 (0%)	4 (4.44%)	0.2986
Buckle exposure	1 (2.13%)	0 (0%)	0.3431
Infection	1 (2.13%)	1 (1.11%)	1
Buckle failure	7 (14.89%)	21 (23.33%)	0.3473
Re-retinal detachment	5 (10.64%)	21 (23.33%)	0.1165
Epiretinal membrane	5 (10.64%)	11 (12.22%)	0.78
Missed retinal breaks	4 (8.51%)	7 (7.78%)	0.89

When it comes to SB surgery, the utilization of CASB offers a few significant advantages over the more conventional SB.[2] First, the chandelier delivers directional lighting with focused illumination that can be controlled to create dynamic shadowing and visualize small retinal breaks, unlike the IO's diffuse illumination.[2] Second, the high magnification offered by the surgical microscope in conjunction with WAVS is far superior to the limited magnification provided by the indirect ophthalmoscopy visualization method.[8] Other benefits of chandelier-assisted surgery include improved visualization in the presence of media opacity and small pupils, better posture for operating surgeons, and better documentation in teaching and training.[2,14] Despite the advantages of chandelier-assisted vitrectomy, this technique may not be feasible for every center due to the cost associated with WAVS.

Currently, both non-contact and contact wide-angle lens viewing systems are widely utilized for vitreoretinal surgical viewing. Both systems have the possible benefits that have been outlined above, and they each have a handful of theoretical drawbacks at most.[8,15-17] While contact-based WAVS can correct corneal aberrations and offer excellent clarity, it frequently needs surgical assistance to keep the lens in place if the operating surgeon is not comfortable doing so. Non-contact-based WAVS, on the other hand, eliminates the requirement for an assistant to hold the lens in place during surgery, but the viewing angle is expected to be limited when compared to the contact-based system.[18] A comparative analysis of intraoperative image quality between the two WAVS approaches concluded that in most cases, the difference was not clinically significant and did not hinder safe and effective surgery.[19] The authors did note, however, that the contact method appeared to provide a higher image quality and/or a broader viewing angle in difficult circumstances.[19] In addition, maintaining the contact lens in place was reported to be a moderate challenge.[19] Contact lens also raises the likelihood of intraoperative release of iris pigment and postoperative epithelial defects, both of which can have an adverse effect on visualization compared to a non-contact system.[20] While it is possible to perform scleral depression with a contact lens in place, doing so presents additional technical challenges.[20] This could conceivably impair peripheral vitreous shaving, which, in turn, could affect the complete release of all traction.[20] A recent multicenter comparative study evaluating the surgical outcomes of PPV utilizing two distinct WAVS approaches for primary non-complex RD repair showed that there was no statistically significant difference in the anatomic success obtained for primary RD repair using the two WAVS approaches.[18] Currently, the selection of contact versus non-contact WAVS for retinal surgeries is largely based on the surgeon's personal preference, as there is insufficient data available to compare the outcomes of these two viewing systems. Consequently, further research is needed to better understand the efficacy of contact versus non-contact WAVS for retinal surgeries and help provide surgeons with more informed decision-making capabilities. Our research is the first to directly compare the two viewing systems in terms of surgical and functional outcomes of CASB surgery in RRD patients, which is a critical step toward addressing these lacunae. Our analysis revealed no significant differences in the rates of retinal attachment (85.11% of C1 patients and 76.67% of C2 patients, $P = 0.3473$) or final visual outcome (VA ≥ 20/40 in 61.7% of C1 patients and 46.67% of C2 patients, $P = 0.14$) between the two viewing systems.

Despite recent research mentioning ERM as a postoperative consequence of CASB,[14] we did not notice it in such a disproportionately high percentage in any of the treatment groups during the first 6 months after follow-up. In addition, there was no discernible gap in incidence rates among the various groups ($P = 0.78$). The incidence of other common complications such as infections, glaucoma, cataracts, and buckle exposure was comparable in both groups. Also, the two

types of anesthesia used in the two centers and the comparison of non-drainage versus drainage of subretinal fluid (SRF) did not produce any notable differences in the anatomic and functional outcomes, which is consistent with the earlier research.[21-24] Thus, both non-contact–based and contact-based WAVS approaches are demonstrated to be safe, effective, and successful methods of treatment for primary RD by CASB, with no significant differences in ERM incidence rates or other postoperative problems, as shown by our findings.

Our study has a few limitations. Since our study was conducted at two different sites, there were differences in the number of patients, lens status (phakic or pseudophakic), type of anesthesia, and choice of SRF drainage that could not be avoided. But numerous earlier investigations have demonstrated that neither the kind of anesthesia used nor the selection of SRF drainage affects the final surgical or visual results of SB surgery.[21-24] Therefore, the impact of these differences on our study was minimal and was not likely a major factor in our results. In addition, patients in both groups underwent surgery with different health-care professionals, which could have an impact on the outcomes. However, because both surgeons had extensive surgical experience that was fairly comparable, it is unlikely that the final outcome will be affected. Furthermore, baseline variables such as sex ratio, myopia status, number of breaks, PVD status, and macular on/off status of patients in the two treatment groups were not substantially different, with a similar percentage of patients in both groups having RRD caused by retinal dialysis. In both groups, the majority of patients were phakic, whereas just a small number of patients were pseudophakic. Such a patient distribution is plausible, as previous research has shown that, when compared to PPV, SB is more beneficial for patients with phakic eyes than those with pseudophakic eyes.[1,3,5] The intergroup difference in this regard is most likely related to the larger number of patients in group C2. Similarly, although the difference in patient age is statistically significant between the two groups, it is unlikely to have an impact on the study due to the patients' similar health backgrounds and circumstances. Furthermore, despite the significant difference, both cohort populations were young adults, with a mean age of 29 years in C1 and 24 years in C2. Therefore, it is unlikely that the patients' backgrounds, particularly their ages, will have an impact on the results of the study. One of the limitations of the study was that the operating surgeons of each group did not have a comparison group where they had operated with the other type of WAVS. Therefore, intraobserver variations could not be derived from the data. In addition, the retrospective nature of the study posed some limitations, for example, the quantification of the requirement of indentation could not be done. However, the individual surgeons were comfortable operating with their own WAVS and did not find any difficulty with indentation, cryopexy, or assistant-independent lens manipulation. For the same reason, comparison of the illumination level of individual cases in each group was not possible. However, cases operated with the same endoillumination intensity in each group did not show any difference in illumination level on comparing the surgical videos. This, however, was a subjective judgment and depended on many factors including the surgical microscope and recording system. Further research, such as a longer-term study with diverse age populations, would be required to validate the results of this study and demonstrate whether the difference in age between these two groups could have a meaningful effect on the outcomes.

Indeed, the large sample size, multicenter design, and novel comparative evaluation of WAVS in CASB surgery are some of the biggest strengths of this study. These strengths offer increased confidence in the results and greater generalizability of these findings to other institutions and surgeons. These advantages lay a robust foundation for future research into comparing the performance of various WAVS approaches, not just in CASB but in other vitreoretinal surgeries as well.

Conclusion

Based on our data from the two groups of patients, we can conclude that none of the two types of WAVS used in CASB surgery is superior to the other in terms of surgical and functional outcomes, as well as postoperative complications. This maximizes viewing platform adaptability, which benefits the surgeons by allowing them to freely choose between the systems based on their convenience to optimize their surgical view. While the surgical and functional outcomes and the postoperative complications of the two methods are comparable, the two WAVS systems differ slightly in terms of convenience, ergonomics, and operation cost. Therefore, further research is warranted to assess the benefits and drawbacks of the two WAVS approaches in vitreoretinal surgeries with regard to their levels of safety, efficacy, efficiency, ergonomics, and cost-effectiveness to the health-care system.

Written informed consent

The authors have obtained written informed consent from each patient enrolled in the study.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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