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ORIGINAL ARTICLE

Efficacy of Novel Endoillumination Assisted Modified Scleral Buckling versus Conventional Scleral Buckling

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ABSTRACT

Scleral buckling (SB) has proven to be an effective surgical technique for RRDs especially in patients with uncomplicated rhegmatogenous retinal detachment (RRD) not associated with proliferative vitreoretinopathy (PVR). Until recently, it was still the most commonly employed surgical technique in dealing with RRDs with a high success rate. with the advent of the modern retinal viewing systems and vitrectomy machines, the trends in dealing with RRD are more inclining towards pars plana vitrectomy. Possible reasons for it are that conventional SB has steeper learning curve and it is assisted by the Indirect ophthalmoscope to view the retina during various steps of the surgery which has smaller inverted image and also its use is cumbersome. with the novel techniques being introduced, the essence of scleral buckling can be preserved and the surgical technique can be made much easier by providing a better viewwith easy localization of retinal breaks. The basic principles and steps of conventional scleral buckling can be well taught and more effectively practiced with the introduction of better illumination and viewing systems. In this study, the efficacy of endoillumination source assisted modified scleral buckling would be determined and compared with the results of conventional scleral buckling.

Objective: To compare the functional and anatomical success rates of conventional scleral buckling for RRD with endo-illumination assisted Wide angle viewing system modified scleral buckling in patients with uncomplicated rhegmatogenous retinal detachment.

Materials and Methods: This is an interventional prospective study being conducted at the Department of Ophthalmology, Peshawar Medical College (PMC) and Allied hospitals from July 1, 2020 to December 31, 2020. The study included 40 patients presenting with uncomplicated RRD, 20 in each group, by simple random sampling technique. Outcome measures assessed were primary visual acuity (VA), primary anatomical success, and peri-operative complications.

Results: 40 patients (40 eyes) were recruited in this study, 20 in each group (conventional scleral buckling group and modified scleral buckling group), who completed a 3 months follow up. 21 (52.5%) were male patients while 19 (47.5%) patients were female. Mean age was 44.3 ± 12.1. New retinal breaks were identified in 3(15%) patients in the MSB group. Retinal reattachment was achieved in 95% patients in both the groups. Cataract Progression was later found in 1(5%) patient in the MSB group. No other complications were recorded in either of the comparative groups. 1(5%) patient each, in both the groups, underwent additional surgeries.

Conclusion: In conclusion, the endolight-assisted scleral buckling using a wide angle visualization system appears to be a promising technique with comparable surgical outcomes to conventional scleral buckling with least complications in specific cases of rhegmatogenous retinal detachment. It can be safely used to meet the surgical need and reduce discomfort during surgery. It is particularly useful in cases with pre-operatively undetected retinal tears. Wide angle viewing system assisted modified scleral buckling technique is highly recommended for teaching purposes.

Keywords: Scleral buckling; Wide angle viewing system, Rhegmatogenous retinal detachment, Modified scleral buckling.

INTRODUCTION

Scleral buckling (SB) was started by ophthalmologists in 1950 for the treatment of rhegmatogenous retinal detachments (RRDs).[1]

Over the years it has proven to be an effective surgical technique for RRDs especially in patients with uncomplicated RRDs not associated with proliferative vitreoretinopathy (PVR).[2] It is commonly employed surgical technique in dealing with RRDs. SB is still in practice and is considered to be significantly effective and a safe measure in the primary management of uncomplicated RRDs even after the advent of modern machines and internal tamponade techniques with a success rate from 82% to as high as 92%.[3]

Conventional SB is assisted by the Indirect ophthalmoscope to view the retina before and during the surgery. The indirect ophthalmoscope is used for visualization of the breaks, application of cryopexy, drainage of subretinal fluid and buckle height adjustment. [4] It is like illuminating a black box from the outside via a light through a hole in the box. Photocoagulation and cryopexy irritates the retinal pigment epithelium (RPE) and the choroid in order to form chorioretinal adhesions. Trans- scleral drainage of the subretinal fluid may or may not be performed depending on the features of the detachment. [4,5] An encircling band or a segmental tyre/plomb is placed around the globe, the height and position of which is adjusted according to the locationof the retinal breaks. [4]With the pars plana vitrectomy in place, newly trained surgeons are reluctant to perform scleral buckling in RRD since the learning curve of the conventional SB is thought to be way steeperwhich has led to a significant decline in the mastery of handling the indirect ophthalmoscopeand performing surgery with an inverted image of the surgical field. [6]However with the novel techniques being introduced, the essence of scleral buckling can be preserved, the basic principles and steps of the conventional scleral buckling can be well taught and more effectively practiced with the introduction of better illumination and viewing systems.

With the recent advances in vitrectomy, cannula based endoillumation techniques are being introduced. [6] With an endo-illumination system in the modified SB, a better illumination, a better fundus view, easy localization of breaks and a higher anatomical success can be achieved. [7] Endolight pipe or a chandelier light source of various gauges are being employed to illuminate the retina. [7,8,9]The anatomical success rate with the conventional SB amounts from 82% to as high as 92%.[3]On the contrary, some studies have reported a primary anatomical success rate of 90.48%[9] and 93.4% [10] with endo-illlumination system assisted modified scleral buckling.

The chandelier endoillumination system compared to an endolight pipe has been considered inferior by some surgeons, reason being, it does not illuminate the retina 360 degrees.

Though, the chandelier endoillumination system is preferable in a vitrectomy setting in cases where a bimanual surgical manipulation of epiretinal membranes is required. [11]Whereas the endolight pipe source can be directed at any part of the retina to illuminate it for performing the different steps of the scleral buckling surgery more efficiently.

However the most dreaded complication with the use of an endolight pipe is the dragging of vitreous while its insertion and going out of the eye, leading to iatrogenic breaks.[12]Though, it has not been widely advocated by previous studies, however, theoretically it is a concern which needs further research. But due to a better illumination with the endolight pipe and due to its greater mobility it can be used to view the retina 360 degrees hence promising a decrease in the chances of missing out on retinal breaks thus leading to higher success ratecompared to an indirect ophthalmoscope assisted SB or when assisted with chandelier illumination system. [7,8,9]

In this study, the efficacy of endolight pipe illumination source assisted modified scleral buckling would be determined and compared with the results of a conventional SB. Though studies have been conducted with regards to determine the efficacy of such novel techniques, further research is necessary in this regard, exhausting work is yet to be performed to compare the anatomical, functional success and complication rates associated with modified scleral buckling assisted with various retinal endoillumination accessories. In this study we will assess the efficacy of such novel techniques.

Objective: To compare the efficacy of conventional scleral buckling for RRD with endo-illumination assisted modified scleral buckling in terms of functional, anatomical success and the complications related to it.

Operational definitions:

Uncomplicated RRD: Rhegmatogenous retinal detachment not associated with retinal vascular occlusive diseases,intraocular inflammation,trauma, choroidal detachment, vitreous hemorrhage, age-related macular degeneration, cataract, y, macular holes, macular edema, glaucoma or preexisting corneal diseases.

Complicated RRD: Rhegmatogenous retinal detachment associated with retinal vascular occlusive diseases,intraocular inflammation,trauma, choroidal detachment, vitreous hemorrhage, age-related macular degeneration, cataract, macular holes, macular edema, glaucoma or preexisting corneal diseases.

Conventional Scleral Buckling: Scleral buckling for RRD which is perfomed with the assistance of an indirect ophthalmoscope to view the fundus.

Modified Scleral Buckling: Scleral buckling for RRD which is performed with the help of an endolight pipe source to illuminate the retina via a sclerotomy.

Anatomical success: Successful surgical flattening or attachment of the retina not requiring any additional vitreo-retinal surgery.

Anatomical success rate: The percentage of successful surgical flattening or attachment of the retina not requiring any additional vitreo-retinal surgery.

Functional success: Improvement in visual acuity of atleast 15 optotypes or 3 lines according to the ETDRS visual acuity scale following successful surgical attachment of the retina.

Functional success rate: The percentage of improvement in visual acuity of atleast 15 optotypes or 3 lines according to the ETDRS visual acuity scale following successful surgical attachment of the retina.

MATERIALS AND METHODS

Study Design: Interventional Prospective study Design.

Setting: Department of Ophthalmology, Peshawar Medical College (PMC) and Allied hospitals, i.e. Kuwait Teaching Hospital (KTH) and Prime Teaching Hospital (PTH).

Duration of Study: July 1, 2020 to December 31, 2020.

Sample Size: 40 patients, 20 in each group.

Sampling Technique: Simple random sampling technique.

Sample selection:

Inclusion criterion:

1. Patients presenting with RRD with age between 15-55 years intended to be managed surgically are included in this study.

Exclusion criterion:

1. Patients presenting with RRD who have a previous history or are diagnosed with intraocular inflammation, vitreous hemorrhage, macular edema,retinal vascular occlusive diseases,anterior proliferative vitreoretinopathy,trauma, macular holes, glaucoma, age-related macular degeneration, cataract, choroidal detachmentor preexisting corneal diseaseswere not included in this study.
2. Patients with a history of co-morbidities like diabetes and hypertension were excluded.

Data Collection: Patients who presented to the Department of Ophthalmology, Peshawar Medical College & affiliated hospitals i.e. Kuwait Teaching Hospital and Prime Teaching Hospital with uncomplicated RRD and advised SB, fulfilling the inclusion criterion, willing to participate in the study were recruited in the study after obtaining an approval from the ethical and research board of PMC.An informed written consent was taken from all the patients to be included in the study.

Patients were assigned into either of the two groups, Group A (conventional scleral buckling), Group B (Modified Scleral Buckling).

Variables such as age, gender, laterality (right/ left eye), lens status (phakia/ pseudophakia) macula attachment and multiple breaks if present were recorded before surgery in all the patients. Number, location and size of break(s) and proliferative vitreoretinopathy was graded and documented. Position of the sclerotomy for endolight was specified i.e opposite to the quadrant with the maximum number of breaks.

SB in all the patients shall be performed under a local/general anaesthesia by a single senior vitreo-retina surgeon. A peribulbar anesthesia was given (4ml xylocaine followed by 3 ml bupivacaine-xylocaine). During the surgery, the break(s) was localized, cryotherapy and drainage of the subretinal fluid (SRF) was performed. Style 240 (Labtician Ophthalmics, Inc., Oakville, Canada) was used in all the patients as an encirclement band. Segmental tyre if needed, style 276 (Labtician Ophthalmics, Inc., Oakville, Canada), was used depending on the location of the retinal break. Two scleral sutures with 5/0 ethibond were placed in each quadrant 3 mm wider than the width of the buckle to maintain the optimum position/ height of the buckle with adequate scleral indentation over the area of the break. In category B, the above-mentioned surgical technique was accompanied by a 25 guage guarded sclerotomy for endolight pipe attached to machine ((Bausch & Lomb, Inc. Millennium™ Microsurgical System) opposite to the quadrant with maximum number of breaks as had already been specified in the pre-op fundus examination with indirect ophthalmoscope. The sclerotomy wassecured with 7/0 vicryl at the end of the surgery. In addition, vitrectomy with the cutter probe was done at the site of the sclerotomy externally, if any vitreous wick was noted after removal of the cannula at the end.

Variables such as age, gender, BCVA (Log MAR), IOP were recorded before the surgery.The intra-operative details of the position of the break in clock hours, segmental tyre if used and its location i.e. in any of the 4 quadrants was noted, new retinal breaks found during the surgery were noted. Intra-operative surgical complications, if any, were noted down such as vitreous hemorrhage, proliferative vitreo-retinopathy (if missed in pre op-exam), vitreous prolapse at the site of sclerotomy, retinal incarceration or iatrogenic retinal tear, scleral laceration, choroidal hemorrhageor lenticular damage.

The patients were examined at post-op day one, after 1 week, 1 month and at 3 months. Variables such asBCVA, retinal attachment and complications, if any, were recorded.

Statistical analysis: The data was analyzed using SPSS version 22.0. All the continuous variables are presented as Mean ± SD while the categorical variables are summarized as frequency and

percentages. Chi square or fisher exact test was applied to determine any statistically significant difference between the two groups (CSBvs MSB). Independent sample t test was applied to compare categorical and continuous variables. All the applied tests were two tailed and the level of significance was set as <0.05.

RESULTS

40 patients (40 eyes) were recruited in this study, 20 in each group (conventional scleral buckling group and modified scleral buckling group), who completed a 3 months follow up. 21 (52.5%) were male patients while 19 (47.5%) patients were female. Mean age was 44.3 ± 12.1. Pre-op BCVA was 1.54± 0.67Log MAR in the CSB group and 1.52± 0.64 Log MAR in the MSB group.

In both the groups, 15(75%) were phakicand 5(25%) were pseudophakic patients with RRD. 9 (45%) patients in the CSB group and 11 (55%) in the MSB group had multiple retinal tears. Macula was attached in 7 (35%) patients in the CSB group and 6 (30%) in the MSB group.

Intra-operative findings recorded showed that encircling 360 band was used in 12(60%) patients in the CSB group and 15(75%) patients in the MSB group. Silicon Tyre was used in 20(100%) patients in the CSB group and 19 (95%) patients in the MSB group. No new breaks were identified in the CSB group BUT in 3(15%) patients in the MSB group. Subretinal Drainage was performed in all the patients in both the groups.

Post-operative findings recorded showed that retinal reattachment was achieved in 95% patients in both the groups. Cataract Progression was later found in 1(5%) patient in the MSB group. No other complications were recorded in either of the comparative groups. 1(5%) patient each, in both the groups, underwent additional surgeries. Post-op BCVA was 0.62± 0.33 log MAR in the CSB group and 0.57± 0.29 Log MAR in the MSB group.

Table 1: Patients characteristics, Intra-operative and postoperative results

	Conventional Scleral buckling (n=20)	Modified Scleral Buckling (n=20)	P-Value
Phakia, n (%)	15 (75%)	15 (75%)	1.00
Multiple retinal tears, n(%)	9(45%)	11(55 %)	0.75
Macula on, n (%)	7(35%)	6(30%)	1.00
Intra-operative			
Encircling 360, n(%)	12(60%)	15(75%)	0.51
Silicon Tyre, n(%)	20(100%)	19(95%)	1.00
New breaks identified, n(%)	0(0%)	3(15%)	0.39
Subretinal Drainage, n(%)	20(100%)	20(100%)	1.00
Post-operative			
Reattachment, n(%)	19(95%)	19(95%)	1.00
Surgically induced breaks, n(%)	0	0	-
Cataract Progression, n(%)	0	1(5%)	1.00
Endophthalamitis, n(%)	0	0	-
Additional Surgeries, n(%)	1(5%)	1(5%)	1.00
Pre-op BCVA	1.54± 0.67	1.52± 0.64	
Post-op BCVA	0.29± 0.16	0.34± 0.23	

DISCUSSION

Despite the recent advances in vitreoretinal surgery gadgets and techniques for RRD, primary scleral buckling surgery is still a preferable technique in the management of certain types of rhegmatogenous RD with a high anatomical and functional success rate.[13]

A study conducted to compare the outcomes of the traditional SB vs pars plana vitrectomy in RRD study (SPR) concluded that SB has better visual outcomes, decreased number of additional retinal surgeries, a lesser chance of cataract progression and a lesser complication rate.[14] The study emphasized that SB has a vital place in the management of RRDs and the skills and knowledge needed to perform it should be preserved. Despite the clear edge, a progressive reluctance to perform it has been seen presently.

Aras et al in 2012 first reported the use of an endo-illuminated non contact WAVS for the fundus visualization in SB procedures.[15]In the current era, the self sealing Micro-incision vitrectomy surgery has become the referred first choice of surgery in the management of retinal detachment.

While the trendof the scleral buckle technique is now declining with time, this decline is partly due to the better view being provided by the modern viewing systems and the ease of handling the advanced instruments in comparison to the cumbersome handling of the indirect ophthalmoscope and its steep learning curve. [16]

The wide-angle viewing system has gained its edge due to panoramic view of the surgical field while the indirect ophthalmoscope images are small and inverted which cannot be readily shared with the surgical staff and the localization of break(s) is difficult to perform which requires mastery in handling the device. The clear retinal image can be enlarged and viewed even with a small pupil which allows dynamic scleral compression with the cryoprobe using WAVS. While using the endoilluminated WAVS, the magnification and exact visualization of retinal break(s) during surgery significantly improves which helps localize pre-operatively undetected retinal breaks.

An increasing high rate of occupational musculoskeletal disorders in vitreoretinal surgeons is being reported in recent reports suggesting a comfortable posture while performing retinal surgeries is important.[17] The surgeon fatigue due to the prolonged use of the indirect ophthalmoscope can be avoided by using the WAVS.

With a 3D visual system, the ergonomics aspects of the surgeon improves due to the heads-up surgery position of the surgeon and the image of the fundus can also be shared on large screen which can facilitate the surgery assistant in predicting the instruments to be used and can also be used for teaching purposes.[18]

The reattachment rate after vitrectomy and scleral buckling are somewhat comparable in various comparative series.[19]However upon follow up, the re-detachment rate is higher in post-vitrectomy cases due to the epiretinal membranes secondary to the contraction of the residual vitreous.[20]The modified scleral buckling technique has the advantages of both the techniques; a better view of the WAVS and the lesser chances of post-op long term proliferative vitreo-retinopathy.

Comparable to our study, various studies have reported a high reattachment rate of 83.3–95.5% with the use of chandelier-assisted scleral buckling without any significant complications.[2,3,6-10]

Another study which included 25 eyes with RRD with ≤ grade B PVR, wherein no break was localized pre-operativelyand underwent endoilluminator assisted SB,reported a success rate of 95.6% at 2 years follow up.[21] This study concluded that modified SB technique could be employed as a standard protocol in the primary management of selected cases of RRD.

Narayanan et al[22] reported higher reattachment rates of 92% in the MSB group and 85% in the traditional SB group. The surgery duration was shorter in the chandelier assisted surgeries due to the prompt localization of breaks avoiding the time consuming process of using the indirect ophthalmoscope.

However the most dreaded complication is increased risk of iatrogenic tears, cataract progression, vitreous prolapse, vitreous traction and infective endophthalmitis.[12] In our study we encountered cataract progression in only one case in the modified scleral buckling group. No vitreous related complications, iatrogenic retinal breaks, hypotony,retinal phototoxicityor endophthalmitis were recorded in our study. The concern regarding retinal phototoxicity can also be minimized since the digital control system of the microscope can adjust the light brightness upto 40%.

Checking for vitreous wick at the end of the surgery and its removal followedby suturing the wound is necessary in minimizing the chances of surgical complications.The use of a smaller gauge chandelier decreases the vitreous wicking from the wound sitewhich decreases the risk of infective endophthalmitis.

CONCLUSION

In conclusion, the modified scleral bucklingtechnique, using a wide angle visualization system appears to be a promising technique similar to conventional scleral buckling with comparable anatomical and functional success rates, with least complications in specific cases of rhegmatogenous retinal detachment. It can be safely used to meet the surgical need and reduce discomfort during surgery. It is particularly useful in cases with pre-operatively undetected retinal tears. Moreover WAVS modified scleral buckling technique facilitates assistant residents and fellows for teaching purposes.

Limitations: Limitations of the study are that it is not adequately large enough to find a statistically significant superiority of Modified Scleral Buckling in comparison to Conventional Scleral Buckling. Further exhaustive studies with a larger sample would pave the path for it.

REFERENCES

1 Yannuzzi, N. A., & Patel, N. A. (2020). Encircling Scleral Buckle with Chandelier Endoillumination and Endolaser for Repair of Rhegmatogenous Retinal Detachment. 14, 609-612.

2 Noori J, Bilonick R, Eller A. SCLERAL BUCKLE SURGERY FOR PRIMARY RETINAL DETACHMENT WITHOUT POSTERIOR VITREOUS DETACHMENT. Retina. 2016;36(11):2066-2071.

3 Khanzada M, Wahab S. Repair of Primary Rhegmatogenous Retinal Detachment with Macula Off. Pakistan Journal of Medical Sciences. 2014;30(3):525-9.

4 Pak, K. Y., Lee, S. J., Kwon, H. J., Park, S. W., Byon, I. S., & Lee, J. E. (2017). Exclusive Use of Air as Gas Tamponade in Rhegmatogenous Retinal Detachment. Journal of Ophthalmology, 2017, 1341948. doi: 10.1155/2017/1341948

5 Park, S. W., Kwon, H. J., Kim, H. Y., Byon, I. S., Lee, J. E., & Oum, B. S. (2015). Comparison of scleral buckling and vitrectomy using wide angle viewing system for rhegmatogenous retinal detachment in patients older than 35 years. BMC Ophthalmology, 15(1), 121. doi: 10.1186/s12886-015-0109-9

6 Shanmugam, P. M., Ramanjulu, R., Mishra, K. C. D., & Sagar, P. (2018). Novel techniques in scleral buckling. Indian journal of ophthalmology, 66(7), 909-915. doi: 10.4103/ijo.IJO_136_18

7 Assi, A., Abdelmassih, Y., & El-Khoury, S. (2018). ENDOILLUMINATION-ASSISTED MODIFIED SCLERAL BUCKLING. Retina, 38(2), 320-324. doi: 10.1097/iae.0000000000001568

8 Nam, K. Y., Kim, W. J., Jo, Y. J., & Kim, J. Y. (2013). Scleral buckling technique using a 25-gauge chandelier endoilluminator. Retina, 33(4), 880-882. doi: 10.1097/IAE.0b013e31827e2602

9 Roca, J. A., Maia, M., da Cruz, N. F. S., Polizelli, M. U., Chhablani, J., Gangakhedkar, S., . . . Wu, L. (2020). Non-contact wide-angled visualization with chandelier-assisted scleral buckling for primary uncomplicated rhegmatogenous retinal detachment. 258(9), 1857-1861. doi: 10.1007/s00417-020-04737-1

10 Nossair AA, Ewais WA, Eissa SA. Chandelier-assisted scleral buckling using wide angle viewing contact lens for pseudophakic retinal detachment repair. Int J Ophthalmol. 2019 Apr 18;12(4):627-633. doi: 10.18240/ijo.2019.04.17. PMID: 31024818; PMCID: PMC6469566.

11 Hu, Y., Si, S., Xu, K., Chen, H., Han, L., Wang, X., & Ma, Z. (2017). Outcomes of scleral buckling using chandelier endoillumination. Acta Ophthalmol, 95(6), 591-594. doi: 10.1111/aos.13326

12 Wang, Z.-y., Zhang, Q., Zhao, D.-s., & Zhao, P.-q. (2011). Four-Port Bimanual Vitrectomy in Fibrovascular Membrane Removal. Retina, 31(4), 798-800. doi: 10.1097/IAE.0b013e318209b730

13 Agranat, J. S., Douglas, V. P., Douglas, K. A. A., & Miller, J. B. (2020). A guarded light pipe for direct visualization during primary scleral buckling on the Ngenuity platform. International journal of retina and vitreous, 6, 42-42. doi: 10.1186/s40942-020-00246-9

14 Adelman RA, Parnes AJ, Ducournau D. Strategy for the management of uncomplicated retinal detachments: the European vitreo-retinal society retinal detachment study report 1. Ophthalmology. 2013;120(9):1804-8.

15 Heimann H, Bartz-Schmidt KU, Bornfeld N, Weiss C, Hilgers RD, Foerster MH. Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment: a prospective randomized multicenter clinical study. Ophthalmology. 2007;114(12):2142-54.

16 Aras C, Ucar D, Koytak A, Yetik H. Scleral buckling with a non-contact wide-angle viewing system. Ophthalmologica Journal international d'ophtalmologie International journal of ophthalmology Zeitschrift fur Augenheilkunde. 2012;227(2):107-10.

17 8.Seider MI, Nomides RE, Hahn P, Mruthyunjaya P, Mahmoud TH. Scleral Buckling with Chandelier Illumination. Journal of ophthalmic & vision research. 2016;11(3):304-9.

18 Mehta S, Hubbard GB, 3rd. Avoiding neck strain in vitreoretinal surgery: an ergonomic approach to indirect ophthalmoscopy and laser photocoagulation. Retina (Philadelphia, Pa). 2013;33(2):439-41.

19 Chihara T, Kita M. New type of antidrying lens for vitreous surgery with a noncontact wide-angle viewing system. Clinical ophthalmology (Auckland, NZ). 2013;7:353-5.

20 Heimann H, Zou X, Jandeck C, Kellner U, Bechrakis NE, Kreusel KM, et al. Primary vitrectomy for rhegmatogenous retinal detachment: an analysis of 512 cases. Graefe's archive for clinical and experimental ophthalmology = Albrecht von Graefes Archiv fur klinische und experimentelle Ophthalmologie. 2006;244(1):69-78.

21 Schwartz SG, Kuhl DP, McPherson AR, Holz ER, Mieler WF. Twenty-year follow-up for scleral buckling. Archives of ophthalmology (Chicago, Ill : 1960). 2002;120(3):325-9.

22 Gogia V, Venkatesh P, Gupta S, Kakkar A, Garg S. Endoilluminator-assisted scleral buckling: our results. Indian J Ophthalmol. 2014;62(8):893-4.

23 Narayanan R, Tyagi M, Hussein A, Chhablani J, Apte RS. SCLERAL BUCKLING WITH WIDE-ANGLED ENDOILLUMINATION AS A SURGICAL EDUCATIONAL TOOL. Retina (Philadelphia, Pa). 2016;36(4):830-3.