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Microscope-Assisted ab externo Surgery for the Treatment of Primary Rhegmatogenous Retinal Detachment – New Tech Meets Old Art

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Keywords
Chandelier endoilluminator · Indirect ophthalmoscope · Noncontact wide-angle viewing system · Retinal break · Rhegmatogenous retinal detachment · Scleral buckling

Abstract
Aim: To report the outcomes of ab externo surgery using a surgical microscope, wide-angle viewing system, and chandelier endoilluminator (microscope-assisted ab externo surgery) for rhegmatogenous retinal detachment (RRD). ***Methods:*** This was a retrospective study. Consecutive charts of patients with RRD who underwent microscope-assisted ab externo surgery were analyzed. The following demographic parameters were analyzed: age (years), gender (male/female), and eye (right/left). Clinical parameters were axial length (AL) measured in millimeters (mm), preoperative best-corrected visual acuity (BCVA) measured in logarithm of minimum angle of resolution (logMAR), intraocular pressure (IOP), and lens status (phakic/pseudophakic). The parameters of RRD were number and type of retinal breaks, location of retinal breaks, extent of retinal detachment (RD) (number of detached quadrants), and macular detachment (MD), as well as retinal breaks not detected preoperatively. Use of cryopexy, circumferential or segmental scleral buckle, drainage of subretinal fluid, injection of air or gas, and duration of surgery were recorded. The postoperative parameters analyzed were BCVA, IOP and recurrence of RD and postoperative complications. Follow-up was established at 3 months. ***Results:*** A total of 213 eyes (97 right, 116 left) of 205 patients (114 males, 91 females) affected by primary RRD were included. Fifty-two eyes (24.4%) were affected by high myopia (AL >26.5 mm), and 160 patients (75.1%) were affected by RRD caused by a single retinal break and involving only one quadrant. The superior quadrant was the most frequently involved (49.3%). Forty-two eyes (19.7%) were affected by MD. In 13 eyes (11.3%), retinal breaks were not detected preoperatively. The duration of surgery was 75.5 ± 42 min. No significant BCVA changes were observed in the whole group, whereas a significant improvement of BCVA from the baseline (2.83 ± 0.87 logMAR) to each time point of follow-up was observed in the subgroup of patients affected by MD. Six eyes (2.8%) developed a recurrent RD, secondary to proliferative vitreoretinopathy (3 eyes) and secondary to a new retinal break (3 eyes). Two eyes developed a persistent vitreous hemorrhage, and one eye developed a macular hole after 1 week. PPV was performed for both. ***Conclusion:*** Microscope-assisted ab externo surgery is effective and safe, it reduces discomfort, it allows the surgeon to work with both hands free, and provides an adequate visualization of each step being performed.

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Introduction

The history of rhegmatogenous retinal detachment (RRD) surgery has been characterized by exceptional instrumental inventions passing from the revolutionary binocular indirect ophthalmoscope through the development of the buckling technique, diathermy, cryopexy, injection of air, until the advent of the surgical microscope and pars plana vitrectomy (PPV). Ab externo surgery was the first surgical approach for the treatment of retinal detachment (RD), and it has been considered as the gold standard surgery prior to the introduction of PPV [1, 2]. The basic steps for repairing RRD have not changed significantly since ab externo surgery was firstly performed. The technique consists in the application of cryotherapy, tamponade with air or gas and, if the surgeon, based on his experience, believes that it is not enough for the reattachment of the retina, a placement of circumferential or segmental scleral buckling (SB) can be placed and a transscleral drainage of subretinal fluid (SRF) can be performed. Optimal visualization is crucial to the success of this technique, allowing the surgeon to perform every step with precision and safety. Funds observation is performed by an indirect ophthalmoscope and a hand-held convex lens. The surgeon examines an inverted, real image. The importance of the proper manipulation of the lens should be mastered. For these reasons, many surgeons prefer to perform PPV as the treatment of choice. PPV has improved over time, the instruments have become more precise and more efficient, and the viewing systems allow the surgeon to have a good visualization during the surgical maneuvers. Today, therefore, the choice of PPV for managing RRD is quite varied among surgeons: some believe that PPV should be used in all cases, and others feel that the ab externo approach should be attempted first in all cases before PPV is done. Recently, in order to overcome the disadvantages of ab externo surgery, a modification of the old technique replacing the traditional indirect ophthalmoscope and a hand-held convex lens with a surgical microscope, a noncontact wide-angle viewing system (WAVS), and a chandelier endoilluminator has been proposed [3–10]. This provides a panoramic view of the surgical field, with optimal visualization of the peripheral retina with good stereopsis. In this study, we have been using microscope, WAVS, and chandelier endoilluminator for performing ab externo surgery for many years, following the same approach described by some of our authors (B.P., J.S.P., and R.F.) for the treatment of myopic traction maculopathy with L-shaped macular buckle [11]. Although this surgical approach has been described in recent years [3–10], except for the paper by Imai et al. [5] (79 cases), the other studies reported a limited number of cases, less than 20 eyes [3–10]. The authors report their experience in the use of microscope-assisted ab externo surgery on a large number of cases evaluating its efficacy, safety, and the advantages compared to the traditional technique.

Material and Methods

The study design was retrospective. A consecutive series of chart of patients affected by primary RRD who underwent WAVS-guided ab externo surgery were analyzed. The study was approved by the local medical ethics committee. At the time of surgery, we informed every participant about the aims, methods, benefits, and potential risks of the treatment. Informed consent was obtained by all participants. All surgical procedures were performed by 4 surgeons (R.F., B.P., G.B., and J.S.P.) from June 2014 to December 2017. Detailed information on previous ocular surgery, demographic and clinical data were collected via retrospective chart review. Demographic parameters included age (years), gender (male/female), and eye (right/left). Clinical parameters were axial length (AL) measured in millimeters (mm), preoperative best-corrected visual acuity (BCVA) measured in Snellen chart and converted in logarithm of minimum angle of resolution (logMAR), intraocular pressure (IOP) measured in mm Hg, and lens status (phakic/pseudophakic). The parameters of RRD were collected from retinal drawing, fundus photography, or report attached to clinical chart and were the following: number and type of retinal breaks, location of retinal breaks, extent of RD (number of detached quadrants), and presence or not of macular detachment (MD). Retinal breaks not detected preoperatively were collected by the surgical reports. Use of cryopexy, circumferential or segmental scleral buckle, drainage of SRF, injection of air or gas, and duration of surgery were recorded. Postoperative parameters analyzed were the following: BCVA, IOP, recurrence of RD and postoperative complications. Follow-up was established at 3 months.

Surgical Technique

The sclera was exposed with a perilimbal conjunctival peritomy, the 4 extraocular rectus muscles were isolated, and tagging was done with 2–0 silk to facilitate positioning of the globe. After examination of the sclera, the surgeon inserted a chandelier endoilluminator with a gauge of 25, 27, or 29 at 4 mm from the corneal limbus. The side of insertion of the chandelier endoilluminator depended on the localization of the retinal breaks viewed preoperatively. The chandelier endoilluminator was inserted on the opposite side of the retinal breaks viewed during the preoperative examination in order to facilitate their visualization. During the surgical maneuvers for buckling placing, the chandelier endoilluminator was removed to avoid the risk of lens touch. For all cases, a circumferential and/or segmental buckling was used. A band of 2.5 mm width and 0.6 mm depth (S2987, 240 style; Labtician Ophthalmics Inc., Oakville, ON, Canada) with a silicon sleeve was used for circumferential buckling. When it was necessary to insert an additional buckling element, silicone tire asymmetrical with an external diameter of 10 mm and an internal diameter of 12 mm was used

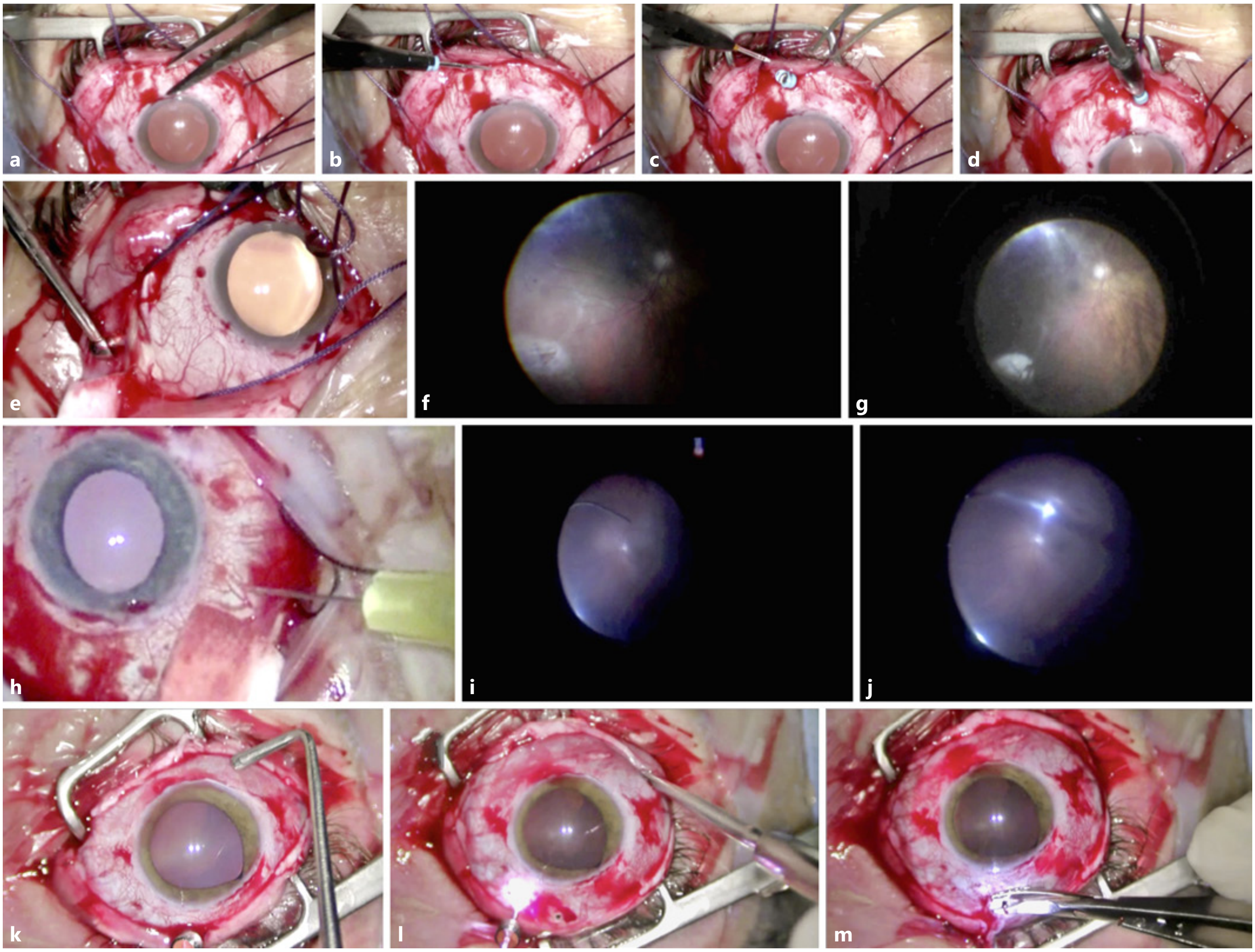


Fig. 1. Surgical steps. **a** Measurement of the distance from the corneal limbus to the sclerotomy site (4 mm) for positioning the chandelier endoilluminator. **b** Port construction of the 25-gauge trocar with single-step technique using angled incision. **c**, **d** Placement of the chandelier endoilluminator. **e** Scleral indentation during the observation of the peripheral retina. **f**, **g** Cryopexy of retinal break viewed by the noncontact wide-angle viewing system. **h–j** Injection of air bubble and check of optic nerve. **k–m** Inadvertent extrusion of trocar from the sclerotomy (**k**) and subsequently vitreous leakage (**l**). Manual cutting of the vitreous leaked.

(S2996, 280 style; Labtician Ophthalmics Inc.). For single break, silicon wedge with a diameter of 14 or 16 mm (S3021/3022996, 135/137 style; Labtician Ophthalmics Inc.) was used. The exact position of the buckling was evaluated by directing the light of the chandelier endoilluminator toward the peripheral retina. Likewise, if required, the surgeon assessed the reduction of the SRF during the drainage. Cryopexy was performed for all retinal breaks. During injection of gas or air, the wide view given by the WAVS allowed the surgeon to check the position of the needle into the vitreous chamber to monitor the central retinal artery perfusion during the air injection and the tensioning of scleral buckling band. At the end of surgery, the chandelier endoilluminator was removed and, if the sclerotomy was not spontaneously closed, a suture with reabsorbable thread was performed before closing the conjunctiva (Fig. 1).

Results

A total of 213 eyes (97 right, 116 left) of 205 patients (114 males, 91 females) affected by primary RRD were included in this study. Demographic and preoperative clinical characteristics of patients are reported in Table 1. Fifty-two eyes (24.4%) were affected by high myopia with AL ≥26.5 mm. Six patients underwent a barrage laser around the retinal break, which progressed to RRD. A total of 160 patients (75.1%) were affected by a RRD caused by a single retinal break and involving only one quadrant. Of 160 eyes with only one retinal break, it was most likely to be in the

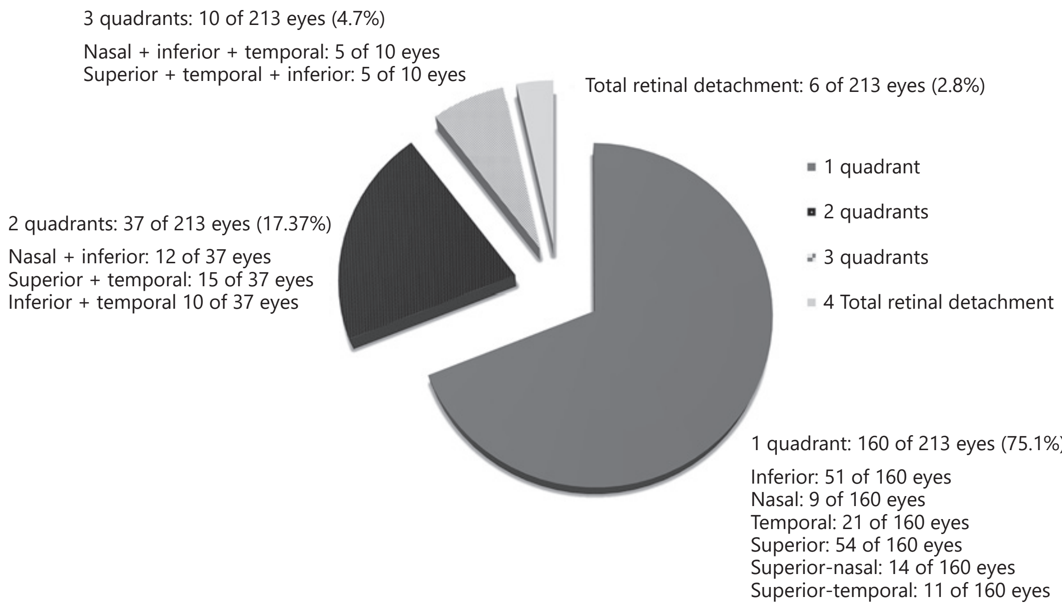


Fig. 2. Extent of RD expressed in quadrants (temporal, nasal, superior, and inferior).

Table 1. Demographic and clinical characteristics of the patients

Eyes, *n*	213
Patients, *n*	205
Gender	
Male, *n* (%)	114 (55.6)
Female, *n* (%)	91 (44.4)
Eye	
Right, *n* (%)	97 (45.4)
Left, *n* (%)	116 (54.5)
Age, years (range)	49.5±16.4 (20–81)
Lens status	
Phakic, *n* (%)	204 (95.8)
Pseudophakic, *n* (%)	9 (4.2)
BCVA (Snellen) logMAR (range)	(20/58) 0.46±0.76 (0–2)
AL, mm (range)	23.8±2.6 (22.3–29.7)
IOP, mm Hg (range)	12.8±1.8 (9–14)

superior quadrant (92 eyes; 57.5%) and least likely to be in the inferior quadrant (10 eyes; 6.25%). Regardless of the extent of RD, the superior quadrant was the more involved (49.3%). Forty-two eyes (19.7%) were affected by MD. The prevalence of the topographic extent of RRD and location of the retinal breaks are reported in Figures 2 and 3, respectively. The type of retinal breaks and the extent of RRD are described in Table 2. In 13 eyes (11.3%), retinal breaks were not detected preoperatively. Cryopexy was performed in all cases. In 121 eyes (56.8%), circumferential buckling was placed. In 45 eyes, an additional segmental buckle was associated. In 92 eyes (43.2%), only the segmental silicon sponge was placed. In 67 eyes (31.5%), transscleral SRF drainage was performed. In 201 eyes (94.4%), gas injection (SF6 0.3 cm^3) was performed, and in 12 eyes (5.6%), air injection was performed (0.4 cm^3). In all eyes, paracentesis of the anterior chamber (AC) was performed before gas or air injection. Vitreous leakage after removal of the chandelier through the sclerotomy was reported by 2 surgeons: 5 cases with a 25-gauge, 4 cases with a 27-gauge, and 3 cases with a 29-gauge. The duration of surgery was 75.5 ± 42 min (range 30–115). No significant BCVA changes were observed in the whole group, whereas a significant improvement of BCVA from the baseline (2.83 ± 0.87 logMAR) to each time point of follow-up was observed in the subgroup of patients affected by MD (Fig. 4). IOP was maintained within normal limits in all patients during the follow-up. SRF was detected in 105 patients (49.3%) in the macular area, in 87 of those (82.9%), it disappeared within the first postoperative month. Six eyes (2.8%) developed a recurrent RD, secondary to proliferative vitreoretinopathy (PVR) (3 eyes) and secondary to a new retinal break (3 eyes). Two eyes developed a persistent vitreous hemorrhage and 1 eye macular hole after 1 week. PPV was performed for both.

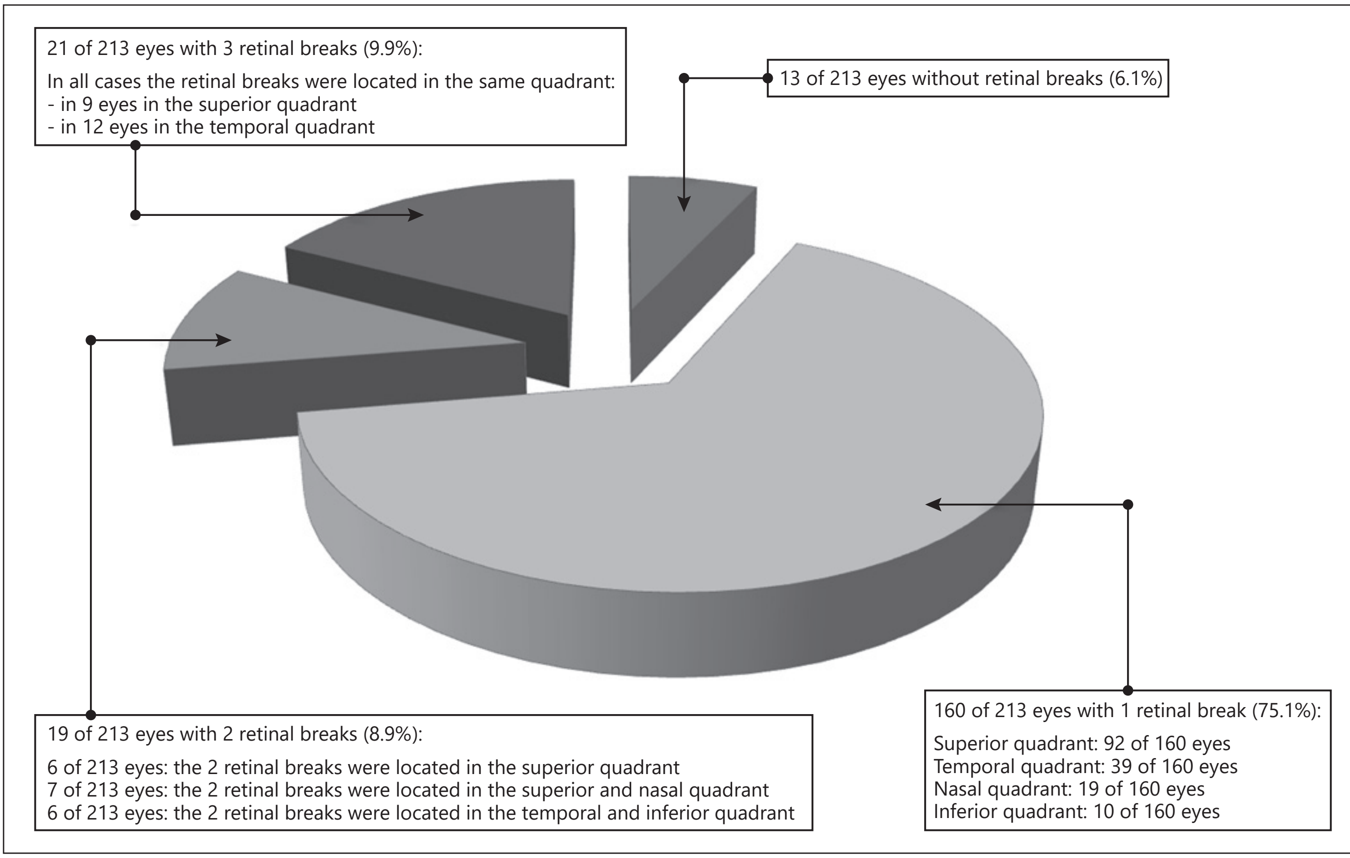


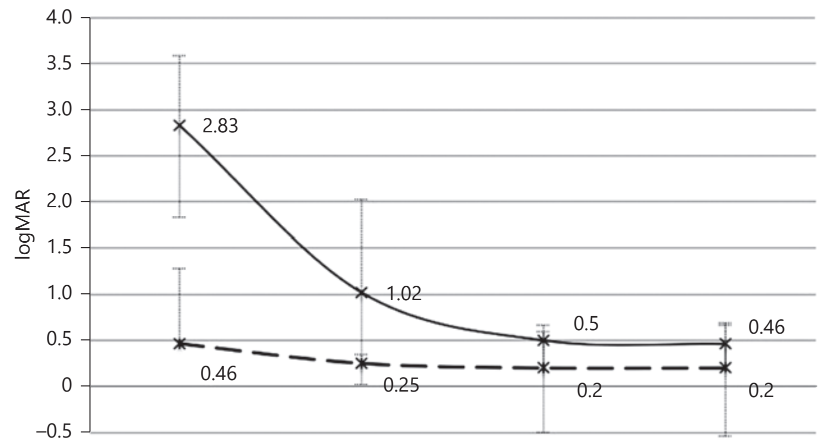
Fig. 3. Number and location of retinal breaks.

Table 2. Characteristics of the retinal breaks and extension of the RD

Retinal breaks, *n* (range)	1.7±1.5 (1–4)
Type of retinal breaks	
Horseshoe tear, *n* (%)	169 (64.8)
Round holes associated with lattice degeneration, *n* (%)	25 (9.6)
Retinal hole, *n* (%)	46 (17.6)
Linear retinal tears with lattice degeneration, *n* (%)	21 (8)
Extension of RD, h (range)	3.5±1.5 (1–11)

Discussion

There are many advantages of the use of microscope-assisted ab externo surgery. The field of observation using WAVS is much larger than that of the indirect ophthalmoscope, allowing the surgeon to always keep the posterior pole and the optic nerve under control. The surgeon can modify the viewing field by the surgical microscope, the focus system control, and magnification of the image. WAVS allows the surgeon to visualize small and anterior lesions. The observation of fundus produced by WAVS is a direct image, differently to that of the indirect ophthalmoscope, allowing the surgeon to perform surgical maneuvers simply and accurately. Moreover, WAVS gives a better panoramic view that overcomes the opacities of the cornea, lens (cataract), capsular bag, and of the vitreous. The ability to place the chandelier endoilluminator in any point of the sclera allows the surgeon to obtain a clear view. The best illumination is achieved when the light rays are perpendicular to the retinal surface. For this reason, we prefer to place the chandelier endoilluminator at the opposite side to break(s) identified during the preoperative examination. In this study, there was no iatrogenic damage of the lens owing to the chandelier endoilluminator. We suggest removing the chandelier when moving the eye or working on the sclera. However, the removal of the chandelier could cause vitreous leakage through the sclerotomy. In the current study, this complication was reported with all



	Baseline	1st month	2nd month	3rd month
Whole group				
Snellen	20 / 58	20 / 36	20 / 32	20 / 32
Mean ± SD (range)	0.46 ± 0.76 (4 – 0)	0.25 ± 1 (3 – 0)	0.2 ± 0.1 (0.8 – 0)	0.2 ± 0.2 (0.8 – 0)
paired sample *t* test $p < 0.005$	–	$p = 0.85813$	$p = 0.31892$	$p = 0.42735$
MD subgroup				
Snellen	20 / 135	20 / 209	20 / 63	20 / 58
Mean ± SD (range)	2.83 ± 0.82 (4 – 1)	1.02 ± 0.1 (1 – 0.4)	0.5 ± 0.46 (0.8 – 0.2)	0.46 ± 0.49 (0.8 – 0.1)
paired sample *t* test $p < 0.005$	–	$p = 0.00421$*	$p = 0.0025$*	$p = 0.0032$*

* statistically significant

Fig. 4. BCVA changes of the whole group and MD subgroup during the follow-up period (3 months).

types of chandelier regardless of the caliber (25, 27, and 29 gauge). We are of the opinion that the vitreous leakage is not related to the size of the sclerotomy. We hypothesize that it could be due to 2 factors: firstly, the technique of sclerotomy construction, it is important to insert the trocar obliquely and not perpendicular to the sclera; secondly, the abnormalities of vitreous (synchisis, syneresis) can play an important role in the induction of vitreous leakage independently from the size of the sclerotomy. The use of a microscope, WAVS, and chandelier endoilluminator allows the surgeon to work with both hands free. The good visualization allows the surgeon to view the exact location of retinal breaks, and to place the buckle in the correct position, reducing the surgical time compared to the traditional technique. The surgeon is able to indent the sclera with cryoprobe and simultaneously with the other hand to check the injection of air or gas in order to move and guide the SRF through the retinal break toward the vitreous chamber. At the same time, the surgeon is always able to check the IOP, evaluating the central retinal artery perfusion. These maneuvers in the traditional technique usually require more than one shift from view by indirect ophthalmoscope and direct view. Microscope-assisted ab externo surgery allows the surgeon to avoid wasting time changing gloves or placing the indirect ophthalmoscope. Based on recent reports on the high rate of occupational musculoskeletal disorders in vitreoretinal surgeons, comfortable methods for performing surgery are important [12, 13]. Less changes in posture between prolonged use of an indirect ophthalmoscope and other surgery steps relieve the surgeon's fatigue. The mean duration of surgery was 72.5 min. This surgical time supports the results reported in the literature [12, 13]. Some authors reported cases of lens damage, light toxicity, and postoperative endophthalmitis [5]. In this study, there was no case of iatrogenic damage of the lens due to the chandelier endoilluminator. Although the insertion of a chandelier illumination converts a non-penetrating surgery to a penetrating one, there was no case of endophthalmitis in this series of cases. In addition, the rate of recurrence of RD secondary to PVR or new retinal breaks was lower than the rate reported in the literature. Imai et al. [5] reported 6 recurrent RDs in a group of 79 eyes who underwent a similar technique for the treatment of RRD. In the current study, a rate of 2.81% (6 of 213 eyes) of recurrent RD due to PVR or new breaks was reported. These results demonstrate the safety and efficacy of this new approach [14–16]. Finally, a few issues must be underlined. Firstly, follow-up was established at 3 months, although it seems to be too short, we considered that 3 months of follow-up were sufficient to give definitive information on the postoperative evolution of these eyes, considering that the risk of PVR, the main cause of failure, is higher within the first 6–8 weeks [17]. Secondly, this technique is of practical relevance only in operating theaters which are equipped with a surgical microscope and a WAVS. Furthermore, the cost of the chandelier endoilluminator must be taken into account, which is usually designed for single use only. In conclusion, on the light of the ever-increasing use of this approach, we want to highlight the efficacy and safety of this technique that combines a rational surgical approach with the advantages of using new instruments.

Statement of Ethics

The authors have no ethical conflicts to disclose.

Disclosure Statement

The authors have no conflicts of interest to declare.

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