Techniques of retroillumination-assisted cataract surgery in combined cataract/vitrectomy surgery

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ABSTRACT

Purpose: To compare the rates of intraoperative posterior capsule rupture, dropped lens nucleus, and zonular instability with use of chandelier versus light pipe illumination in retroillumination-assisted cataract surgery for combined cataract/vitrectomy cases.

Materials and Methods: Retrospective chart review of eyes that underwent retroillumination-assisted cataract surgery in a tertiary center. Patients with age less than 18 years old and incomplete records were excluded. Intraoperative complications were reviewed, and the pre- and post-operative best-corrected visual acuities (BCVA) were compared.

Results: Seventeen cases (9 males, 8 females) were included for analysis, with a mean age of 55.7 years (range 26.6 - 80.8 years). The type of retroillumination used was chandelier (n=12, 70.6%) or light pipe retroillumination (n=5, 29.4%). Out of the 17 eyes, 1 posterior capsule rupture was noted in a case operated with a light pipe. There were no cases of zonular dialysis or dropped nuclear fragments. Another case had a non-expulsive suprachoroidal hemorrhage secondary to a severe coughing episode. Additionally, there were 2 peripheral retinal tears noted during the vitrectomy portions of the cases but were not related to the use of retroillumination light. Patients were followed for an average of 11.6 months (range 1 – 35 months). Mean pre-operative BCVA was 1.87 ± 0.77 LogMAR and improved significantly to 1.05 ± 1.03 LogMAR (paired t-test, p=0.037) at their most recent follow-up.

Conclusion: Retroillumination using chandelier or light pipe illumination is a safe and feasible surgical tool for removing cataracts in eyes with a compromised red reflex.

Keywords: Chandelier, Retroillumination-assisted, Cataract surgery, Phacoemulsification, Vitrectomy.

INTRODUCTION

Pars plana vitrectomy is the standard treatment for many posterior segment diseases. This procedure can be made more challenging with the concurrent presence of a cataract, as this can limit the view to the posterior segment. Combination surgery consisting of phacoemulsification cataract extraction and pars plana vitrectomy has become an increasingly utilized surgical method. Multiple studies have documented its safety and effectiveness.[1,2] Not only does this combined approach spare patients the additional time and expenses of staged procedures, but it has also been shown to have lower complication rates.[3,4]

Pathology of the vitreous, including vitreous hemorrhage and opacities, can limit the red reflex of the eye, which is critical in several steps of cataract surgery. This makes the cataract surgery difficult and increases the likelihood of intraoperative complications, such as posterior capsule rupture. In this context, several methods of retroillumination of the crystalline lens in combined cataract and vitrectomy cases can help highlight crucial structures during cataract extraction and improve the surgeon's visualization.[5-9] In our study, we compared the two most common methods for retroillumination, chandelier and light pipe, in terms of intraoperative complications and surgical outcomes in a series of retroillumination-assisted cataract surgeries.

MATERIALS AND METHODS

This study was conducted in accordance with the

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Declaration of Helsinki. Institutional Review Board approval was obtained from the University of Arkansas for Medical Sciences (UAMS). We collected data by retrospective chart review and identified eighteen cases of combined retroillumination-assisted cataract extraction and pars plana vitrectomy surgery. Two cases were excluded as they had vitreous hemorrhage caused by trauma, which can compromise lens capsule integrity and lead to higher rates of intraoperative complications. Two patients were included in the intraoperative complication analysis but excluded from visual acuity analysis - one patient was lost to follow-up immediately following surgery and the second patient had not yet been seen for a follow-up appointment at the time we conducted this study.

The primary outcome of the study was any intraoperative complication of posterior capsule rupture, dropped lens nucleus, or zonular instability. Secondary outcomes included other intraoperative complications of retinal tears and suprachoroidal hemorrhage, along with postoperative visual acuity. Preoperative visual acuities were compared to the BCVA at the 1-month follow-up visit and the most recent follow-up visit. Statistical significance was determined by a p-value less than 0.05. We had preoperative visual acuity data on all eyes and data at a 1-month (3-6 weeks) follow-up for 13 eyes. We had visual acuity data at the most recent follow-up for 15 eyes.

Surgeries were performed by an attending physician, retina fellow, and resident surgeon at a single institution. All surgeries were performed using the Alcon Constellation system. First, three 25-gauge trocars were introduced 3.5mm from the limbus in the superotemporal, superonasal, and inferotemporal quadrants. At this point, based on surgeon preference chandelier (Figure 1) or light pipe retroillumination (Figure 2) was introduced into the vitreous cavity. A 1-mm side port incision was made into the anterior chamber with subsequent instillation of a mixture of epinephrine and lidocaine followed by viscoelastic. A 2.4-mm clear corneal incision was then made. Retroillumination was turned on at this point to improve the red reflex and enhance visualization of lens structures. Retroillumination remained turned on throughout the surgery with the chandelier and was used selectively during capsulorrhexis and lens cortex removal with the light pipe. A continuous curvilinear capsulorrhexis was accomplished using a cystotome and Utrata forceps. Lens removal was completed using phacoemulsification using the surgeon's preferred technique that included stop and chop or horizontal chop in this series followed by irrigation and aspiration (I/A) for remaining cortical lens fragments. A foldable intraocular lens was implanted into the capsular bag with I/A removal of the remaining viscoelastic. Attention could then be turned to the pars plana vitrectomy portion of the case.

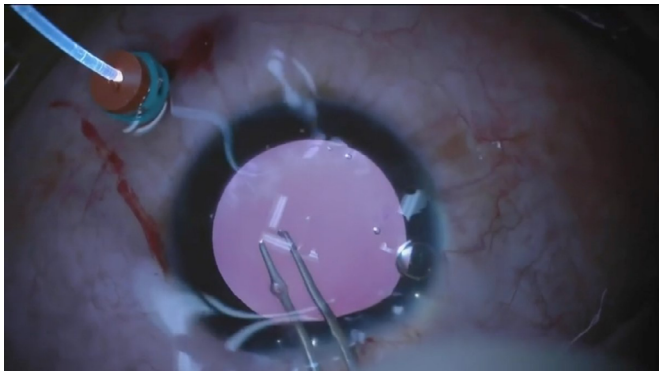

Figure 1: *Chandelier retroillumination-assisted cataract surgery. Note that chandelier illumination is secured in its trocar and does not require manipulation by the surgeon.*

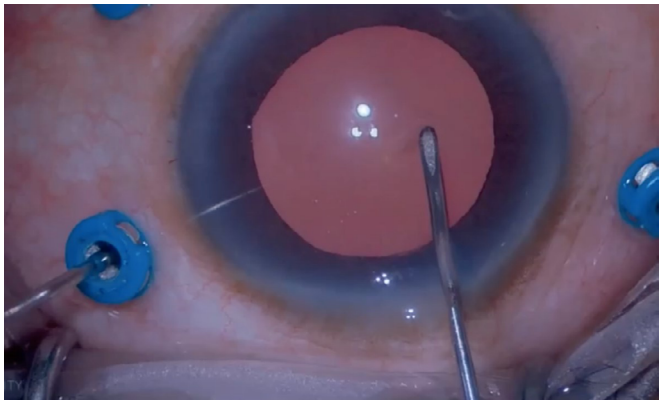

Figure 2: *Light pipe retroillumination-assisted cataract surgery. Note that the light pipe is held and manipulated by the surgeon throughout the surgery, requiring the constant use of one hand.*

RESULTS

Preoperative Characteristics

This study included a total of 17 patients (9 males, 8 females). The mean (SD) age of patients was 55.7 (12.9) years, (range 26.6 - 80.8 years). The average length of follow-up was 11.6 (10.48) months (range 1-35 months). Surgery was performed on 9 right eyes and 8 left eyes. Patients' baseline characteristics are shown in Table 1. The most common cause of vitreous opacification was hemorrhage in the setting of proliferative diabetic retinopathy (n=11, 64.6%). Other causes included hemorrhage secondary to central retinal vein occlusion (n=1, 5.9%), hemorrhagic retinal detachment (n=1, 5.9%), sickle cell retinopathy (n=1, 5.9%), and Terson syndrome (n=1, 5.9%). There was one patient with a history of acute retinal necrosis with

Table 1: *Baseline patient characteristics.*

				BCVA		
Patient	Age (Years)/Sex	Eye	Vitreoretinal Diagnosis	Initial	Final	Follow Up (Months)
1	51/M	Left	PDR with VH	2.3	0	35
2	26/F	Left	ARN with RD	2.3	3	30
3	49/F	Right	PDR with VH	0.48	0.18	23
4	70/F	Left	PDR with VH	0.48	0.1	21
5	50/M	Right	PDR with VH	2.7	1.3	19
6	80/F	Left	CRVO with VH	1.04	2.3	13
7	47/M	Right	PDR with VH	2.3	1.3	9
8	54/F	Right	PDR with VH	1.9	0.18	8
9	59/M	Right	PDR with VH	2.3	0.48	7
10	69/F	Right	VH, MM	2.3	0.1	5
11	62/M	Left	Hemorrhagic RD	2.7	0.54	4
12	69/F	Left	Terson Syndrome	1.9	0	2
13	57/M	Left	PDR with VH	2.7	1.3	1
14	36/F	Right	PDR with VH	0.7	2.7	1
15	48/M	Left	PDR with VH	1.9	2.3	0.25
16	59/M	Right	PDR with VH			N/A
17	52/M	Right	SCR with VH			N/A

PDR= proliferative diabetic retinopathy, VH= vitreous hemorrhage, ARN = acute retinal necrosis, RD= retinal detachment, CRVO= central retinal vein occlusion, MM= multiple myeloma, SCR= sickle cell retinopathy

dense residual vitreous opacifications (n=1, 5.9%) and one patient with vitreous hemorrhage in the setting of multiple myeloma (n=1, 5.9%).

Surgery Characteristics

The majority of cases were performed by a single attending physician (n=11, 64.6%). The remainder of the cases were performed by retina fellow and resident surgeons (n=6, 35.4%). The type of retroillumination used was determined by surgeon preference with chandelier retroillumination used for all attending and resident cases (n=12, 70.6%) and light pipe retroillumination used for all retina fellow cases (n=5, 29.4%).

Outcomes

Primary outcomes

There was one reported posterior capsule rupture in the 17 included cases (5.9%). This occurred in a retina fellow-performed case with the use of light pipe retroillumination, during two-handed chopping without the aid of the retroillumination. We encountered no case of zonular instability or dropped lens nuclei in this series.

Table 2: *Intraoperative complications of retroillumination-assisted cataract surgery*

Intraoperative Complications	
Primary	
Posterior Capsule Rupture	1 (5.9%)
Dropped Lens Nucleus	0
Zonular Instability	0
Secondary	
Retinal Tear	2 (11.8%)
Suprachoroidal Hemorrhage	1 (5.9)

Secondary outcomes

There was one recorded suprachoroidal hemorrhage (non-expulsive) that resulted from a severe intra-operative coughing episode (5.9%). Additionally, a peripheral retinal tear was noted in 2 separate cases (11.8%). These tears both occurred in chandelier retroillumination-assisted cases and were not associated with the chandelier entry site. Preoperative visual acuity averaged logMAR 1.87 (0.77), ranging from logMAR 0.48 - 2.7 (20/60 - light perception). There was a trend toward significant improvement in visual

acuity at the 1-month follow-up, p=0.052. Visual acuities at the most recent follow-up appointment were significantly improved compared to pre-op with an average of logMAR 1.05 (1.03), ranging from logMAR 0 – 2.7 (20/20 – light perception), p=0.037.

DISCUSSION

This study compared retroillumination assisted cataract surgery using a chandelier light versus light pipe at a single academic institution, with surgery being performed by different surgeon grades. We found that both techniques improved the visualization of the cataract surgery steps and enabled surgery to be completed with minimal intraoperative complications.

The results of the current study are in agreement with past studies that examined the safety and efficacy of light pipe-assisted retroillumination and those that focused on the use of chandelier light for this purpose.[5-9] Those studies demonstrated no intraoperative complications.[5-9] Similarly, our study noted no zonular weakness or dropped lens nuclei. There was one recorded posterior capsule rupture that occurred with the use of light pipe retroillumination, during two-handed chopping without the aid of retroillumination. Compared to chandelier retroillumination, the light pipe requires the constant use of one hand to steady the illumination source. As a result, only one hand is free to perform cataract extraction steps that require retroillumination, and any two-handed steps will lack retroillumination. Presumably, this results in a steeper learning curve with higher rates of intraoperative complication early on. However, the light pipe may easily be angled anteriorly during cortical extraction, and some surgeons may find it beneficial to illuminate cortical lens matter. Conversely, bimanual irrigation/aspiration cannot be done using the light pipe method; it requires the surgeon to use a coaxial irrigation/aspiration handpiece with single-handed technique. Finally, the use of a chandelier light considerably adds to the cost of surgery as compared to use of a light pipe, which is part of the supplies routinely utilized during pars plana vitrectomy surgery.

We evaluated other intraoperative complications of suprachoroidal hemorrhage and retinal tear secondarily as these complications are not directly related to the cataract extraction portion of the surgery. There was one reported SCH secondary to a severe coughing episode. Additionally, there were 2 separate retinal tears noted during membrane peeling for PDR and ARN. To our knowledge, other studies evaluating retroillumination-assisted combination surgeries have not evaluated these outcomes. However, previous research on intraoperative complications of diabetic retinopathy surgery has shown iatrogenic breaks to occur in more than 15% of cases.[10]

We anticipated that use of the light pipe may increase the risk of iatrogenic retinal tear due to vitreous traction as the light pipe is introduced in the vitreous prior to the vitrectomy step. Kim et al. also raised the concern that intravitreal light pipe movement may increase the risk of iatrogenic retinal tears during surgery.[11] Our data did not support this hypothesis as both retinal tears occurred in chandelier retroillumination-assisted cases and were noted during the retinal membrane peeling portion of the case after the cataract extraction had already been completed.

Visual acuity was also measured as a secondary outcome as all eyes included in this study had significant posterior segment disease including proliferative diabetic retinopathy, ARN, CRVO, and retinal detachment. These retinal pathologies can negatively affect visual acuity outcomes, independent of the success of cataract surgery. Previous studies on this topic have shown similar results with a wide range of visual acuity outcomes, more so based on retinal pathology rather than cataract surgery success.[7,9]

Our study had several limitations. Firstly, the retrospective design introduces inherent selection biases. Additionally, we had a relatively small sample size though comparable to other studies that have been performed in this area of research. It should also be noted that not all patients had follow-up data at all time points as is often the case with a retrospective review.

One of the advantages of our study was that, to our knowledge, this is the first study of this type to include data from resident and fellow-level surgeons. The fact that intraoperative complications remained low with surgeons who are in training supports that retroillumination-assisted cataract surgery is a safe procedure. Additionally, we believe this is the first study providing data for both chandelier and light-pipe illumination cases. Our contemporary data adds to the growing body of literature supporting the use of retroillumination-assisted cataract surgery in the appropriate clinical setting.

In conclusion, we found very low rates of intraoperative complications in combined retroillumination-assisted cataract and vitrectomy surgeries using either light pipe or chandelier illumination. There was only one recorded posterior capsule rupture and no zonular weakness or dropped lens nuclei. Overall, retroillumination techniques

provide surgeons with a viable alternative procedure for cataract surgery when the red reflex is compromised due to vitreous opacities.

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