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***Corresponding author:** Fernando Aguirre Balsalobre, Servicio Oftalmología. Hospital Universitario San Juan de Alicante. Ctra. Nnal. 332, Alacant-Valencia, s/n, 03550 San Juan de Alicante, Alicante, Spain, Tel: +34965 16 94 00; E-mail: faguirr88@hotmail.com

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Research Article

Evaluation of two techniques for irrigation/aspiration retrolental viscoelastic removal in cataract surgery

Fernando Aguirre Balsalobre^{1*}, Paz Orts Vila², Fernando Hernández Pardines², Víctor García Conca², Sara Núñez Márquez³ and José Ramón Hueso Abancéns⁴

¹Department of Ophthalmology, San Juan University Hospital, Alicante, Spain

²Ocular Motility Section, Oftalvist Alicante, Spain

³Hospital Universitario San Juan, San Juan (Alicante), Spain

⁴Ophthalmologist department director, San Juan University Hospital, Alicante, Spain

Abstract

Purpose: To compare surgical results after phacoemulsification using two different techniques for removal of Ophthalmic Viscoelastic Device (OVD).

Methods: A randomized prospective study was conducted on 77 patients who underwent cataract surgery. In the first group, OVD was removed over the optic by small abrupt horizontal and vertical displacements of the IOL. In the second group OVD was removed by placing the I/A probe behind the IOL. Intraocular Pressure (IOP), Intraocular Lens Position (IOLP) and refraction were analyzed over the first six weeks.

Results: Results in both groups were similar in axial length, keratometry, intraocular lens, age, sex, spherical equivalent and anterior chamber depth. IOP, refraction and IOLP were similar after surgery, and no statistically significant differences were found. The mean refractive change along the first six weeks was 0.33 diopters for the first group (removal only over the IOL) and 0.28 diopters in the second group ($P=0.38$). IOL shifting along the first six weeks was of 0.18 mm for the first group and 0.11 mm for the second group. The difference between groups for this parameter, nearly reached statistical significance ($P=0.057$). No complications were reported with this maneuver.

Conclusions: The aspiration of retrolental OVD (behind the IOL) appears to be a safe maneuver, but it has not proved to offer any advantages. According to our results, displacing the retrolental OVD by subtle taps on the IOL has been enough to avoid secondary postoperative intraocular pressure spikes and IOL shifting in first 6 weeks.

Introduction

The use of Ophthalmic Viscoelastic Devices (OVD) is a common practice in modern cataract surgery. Several viscoelastic substances with different physical and mechanical behaviour are commercially available at the moment. Dispersive viscoelastic agents are preferred to perform the earliest stages of cataract surgery, in order to provide protection from potential damage to intraocular structures. On the other hand,

removal of dispersive viscoelastic materials by aspiration is generally more challenging [1].

Subsequently, a high density cohesive viscoelastic substance can be injected between the dispersive viscoelastic agent and the corneal endothelium for additional safety and to diminish corneal compromise (Arshinoff's shell technique also known as the soft shell technique or SST) [2].

Besides, the use of a cohesive viscoelastic device at this



point of the surgery will help minimising intracameral volume loss during rhexis [3] as well as postoperative Intraocular Pressure (IOP) peaks [4].

The third type of OVD available is viscoadaptative OVD, also difficult to remove from the anterior chamber, more than dispersive OVD for some authors [5] and slightly easier according to others [6]. Viscoadaptative OVD is also suitable to perform Arshinoff's Shell Technique (SST).

Capsule expansion before (intraocular lens) IOL implantation is preferred to be performed by using a cohesive OVD as it can be removed faster. High density OVDs are rarely used for this step.

It is a broadly accepted principle for cataract surgeons not to leave any foreign substances inside the eye after surgery. Complications such as postoperative increase of IOP, amongst others [7] have been reported when OVD has only been removed partially from the Anterior Chamber (AC).

Nevertheless, thorough aspiration of OVD, especially if located behind the IOL can be challenging. In our clinical setting, most surgeons perform I/A aspiration only within the anterior aspect of the eye, over the IOL.

To help retroental viscoelastic evacuation, small sudden taps on the optic of the IOL can be performed both in a horizontal and vertical motion. Despite this manoeuvre, remaining viscoelastic can often be found between the IOL and the posterior capsule.

Remaining OVD trapped behind the IOL can alternatively be removed by placing the Irrigation/Aspiration (I/A) tip posteriorly, letting the aspiration port face upwards throughout the whole process to avoid inadvertent capture of the posterior capsule.

The aim of the comparative study below is to analyse the outcome, in our hands, of both surgical techniques.

Material and methods

A randomized prospective study was conducted on patients undergoing cataract surgery at San Juan University Hospital (Alicante, Spain). Patients were consecutively included in one group or the other. The first patient in group 1, the next patient in group 2, and so on. Thus, patients whose order of inclusion in the study was odd were included in group 1, and pairs in group 2.

Patients with history of Ocular surgery, including intravitreal injections, were excluded, as well as those diagnosed with ocular conditions such as corneal dystrophies, ocular hypertension, glaucoma, retinopathy, pigment dispersion and pseudoexfoliation. Patients with idiosyncrasies that made us suspect a non- straightforward surgery or those standing higher than average likelihood of complications (lack of cooperation, poor mydriasis, concomitant limbal incisions, implantation of toric lens) were not included either

Eyes with extremely high or low axial length or keratometry measurements, and those which required corneal suture or

anaesthetic techniques other than topical + intracameral were also excluded from our study.

In the first group OVD removal was performed by I/A aspiration over the IOL. Following the IOL implantation the I/A hand piece was used to remove as much OVD as possible from the anterior aspect of the eye by slightly shifting and tilting the IOL with the tip. Small sudden touches on the lens were also performed both horizontally and vertically as well as controlled partial decompressions to cause the anterior chamber (AC) to collapse and force evacuation of the OVD remainings entrapped posteriorly.

In the second group, during OVD removal, the I/A probe was not only placed in the AC but also behind the IOL, keeping the aspiration Port visible at all time as a safety measure.

The exact same protocol was used for all patients. Preoperative tests performed were: thorough interview with the patient about personal and family history of ophthalmic and general conditions, best corrected visual acuity, IOP, slit lamp examination, LOCS III cataract classification, fundus examination, eye alignment tests, lacrimal irrigation, endothelial cell count, autorefraction/autokeratometry (Topcon KR8900, U.S.A.), AC Optic Coherence Tomography (OCT) to measure AC depth and angle to angle distance (Visante OCT- Carl Zeiss, Dublin, CA) and ultrasound biometry for IOL calculation and axial length measurements (OcuScan RxP Alcon laboratories UK).

In all cases of both groups was used the intraocular lens Lentis L-313 (Oculentis, Germany).

The preoperative assessment performed by the anesthesiology Department consisted on blood tests, EKG, chest x-ray, and clinical interview.

During 3 days prior the surgery, all patients followed the same lid hygiene routine as well as a prophylactic treatment with diclofenac and moxifloxacin drops. The day of the surgery tropicamide, cyclopentolate and phenylephrine were instilled to achieve and maintain maximum mydriasis.

Chronologically all surgical steps where as follows: Patient was requested to lay down in supine position. Numbing drops (oxybuprocain 1 mg/ml plus tetracaine 4 mg/ml) were administered. A disinfectant solution (Betadine) was applied on the surgical field. After that, an sterile fenestrated drape was placed over the patient's eye, always trying to keep the eyelashes away from the surgical field. An ophthalmic speculum was adapted to the patient's lid to maintain the eye open and avoid the eyelashes to interfere with the surgery.

A 1 millimetre or smaller paracentesis is then performed. Dispersive OVD is placed into the AC to stabilize the eye in order to tailor a 2.2 millimetre wound, preferably in the steepest axis, when possible.

After that, the AC is refilled with high density cohesive OVD in order to facilitate a straightforward continuous curvilinear capsulorhexis within the limits of the optic area of the IOL, after which, hydrodissection and hydrodelineation are



completed. The Phacoemulsification System used in all cases was Stellaris (Bausch + Lomb), most times using the Stop and Chop or the Crater Chop technique.

After polishing the bag free of cortical remains with the I/A probe, 2.0 NaH, 2%Na-Hyaluronate (Oculentis) is used to replenish the bag to facilitate IOL implantation with a Monarch III injector. A monofocal Lentis L313 (Oculentis) IOL was implanted in all cases. This acrylic lens has a plate-haptic design and its measurements are 11x6mm. Its surface has hydrophobic properties.

OVD removal was performed using one of the methods described above. Lastly, the incisions were sealed by hydrosuture.

Postoperative treatment consisted on two doses of oral acetazolamide (250mg within the first hour after the surgery and 250 mg six hours after the surgery), topic cicloplentolate b.i.d., topic diclofenac q.i.d. and topic moxifloxacin q.i.d. For the first week and a combination of topic tobramycin+dexametasona in a tapered fashion for 6 weeks.

The postop checks were performed by the same two expertise surgeons who made the surgeries, supported by a resident. Therefore, although follow-ups were performed without knowing the group assignment, it should not be considered a blind study due to the proximity of the first appointment.

The first follow up appointment took place 24 hours after the surgery and consisted on slit lamp examination of the anterior and posterior aspect of the eye as well as IOP measurement. The two upcoming appointments with the patient were arranged for postoperative week one and six. In both medical visits, patients underwent the following tests: Autorrefraction/Autokeratometry, OCT-Visante, visual acuity, IOP, AC and fundus slit lamp examination.

The following parameters were analysed and compared in this study: IOP, refractive error (spherical equivalent) and OCT-Visante IOL position determination. Variations within the first six postoperative weeks for the variables "spherical equivalent" and "IOL position" were also monitored. The IOL position was measured with OCT-Visante (Zeiss Meditec, Dublin, CA). Using the calliper function, the distance from the endothelium to the anterior surface of the IOL was calculated.

All data went through a computer-based analysis (SPSS 15.0) with parametric statistical tests (Student's T test) to compare the differences between group means. Variables were analysed using Levene's test for equality of variances. If so, Student's T test was applied to compare the means of the variables between the two groups.

Results

81 eyes from 77 patients were included in the study. All surgeries included took place within a period of 3 months.

The first group in which the I/A probe was not introduced behind the IOL was composed of 41 surgeries. In the last phases

of most surgeries, the remaining OVD was often visible behind the IOL.

The second group was formed by 40 surgeries. In this group the I/A probe was used not only in the AC but also behind the IOL. In those patients we achieved total evacuation of OVD with no visible remains in the AC.

Both groups were similar in age (mean age in the first group was 72,05 and 71,73 in the second group) with an even proportion of male and female participants (21 men and 20 women in the first group and 19 men and 21 women in the second group).

Eye features were also similar in axial length, keratometry, IOP, spherical equivalent, AC depth (Table 1).

No clinically and /or statistically significant differences were found between the two groups in IOP, refractive error and IOL position (Table 2).

Refractive changes along the 6 first postoperative weeks were 0,33 D for group 1 (AC only OVD removal) and 0,28 for group 2 (retrolental OVD removal). P= 0,38 (Table 3).

Table 1: Distribution of Ocular variables.

	Group	N	Mean	Tip. Dev.
EsEq	1	41	0.21	0.44
	2	40	-0.35	0.66
K mean	1	41	43.85	0.21
	2	40	43.76	0.22
AL	1	41	23.06	0.15
	2	40	23.15	0.15
IOP	1	41	17.36	0.75
	2	40	17.05	0.92
ACD US	1	41	3.14	0.05
	2	40	3.04	0.05
ACD OCT	1	41	2.72	0.06
	2	40	2.72	0.05

Group 1: OVD removal only from the AC; Group 2: Anterior and retrolental OVD removal; EsEq: spherical Equivalent; K mean: Mean K; AL: Axial Length; IOP: Intraocular Pressure; ACD US: Anterior Chamber Depth Ultrasound Measurements; ACD OCT: Anterior Chamber Depth; Visante measurements.

Table 2: Measurements comparative.

	Group	Mean	Tip dev	P	95% IC	
IOP week	1	16.60	4.09	0.055	-0.05	4.45
	2	18.80	5.85			
IOP last	1	15.69	3.51	0.229	-0.56	2.30
	2	16.56	3.01			
EsEq week	1	0.51	0.40	0.301	-0.25	0.079
	2	0.42	0.34			
EsEq last	1	0.47	0.32	0.637	-0.18	0.109
	2	0.44	0.33			
ACD week	1	3.87	0.34	0.992	-0.14	0.14
	2	3.87	0.30			
ACD last	1	4.04	0.33	0.210	-0.24	0.05
	2	3.94	0.35			

Group 1: OVD removal only from the AC; Group 2: Anterior and retrolental OVD removal; IOP week: IOP one week after surgery; IOP last: IOP six weeks after surgery; EsEq week: spherical equivalent one week after surgery; EsEq last: spherical equivalent six weeks after surgery; ACD week: AC depth one week after surgery; ACD last: AC depth six weeks after surgery



Table 3: Mean comparative.

	Group	Mean	Tip dev	P	95% IC	
EsEq change	1	0.12	0.42	0.57	-0.22	0.12
	2	0.07	0.33			
EsEq difference	1	0.33	0.28	0.375	-0.16	0.06
	2	0.28	0.19			
ACD change	1	0.18	0.28	0.057	-0.15	0.002
	2	0.11	0.10			

Group 1: OVD removal only from the AC; Group 2: Anterior and retrolental OVD removal; EsEq change: Spherical equivalent variations along the first six weeks after surgery (plus or minus sign not being considered); EsEq difference: Spherical equivalent variations (expressing all values in positive numbers); ACD change: AC depth variations six weeks after surgery determined by Visante-OCT

Postoperative IOL position shifting after the 6 first weeks after the surgery was 0,18mm in the first group and 0,11 in the second group. This subtle difference did not reach statistical significance ($P= 0,057$) (Table 3).

In all groups compared, the samples followed a normal distribution. Data was analyzed using Levene test for equality of variances. There were no surgical complications secondary to the OVD removal techniques described above. No patient presented postoperative increase of IOP at the first follow-up appointment after surgery. No steroid responsive ocular hypertension or postoperative uveitis was described either.

Discussion

Even though AC maintainer devices are available in order to diminish intrasurgical IOP fluctuations during all phases of the surgery and expand the bag in order to avoid AC to collapse [8,9], most surgeons prefer to use OVD for that purpose.

Low density cohesive OVD are used preferably for bag expansion before IOL implantation, because its aspiration is easier and they tend to produce less IOP spikes after surgery [10-13]. In our study, we used a low density cohesive OVD for the last phases of the surgery.

Despite OVD aspiration only from the middle of the AC with no manipulation of the IOL, it is known to be ineffective to achieve complete evacuation [14], authors have not agreed yet on the gold standard technique for this step of the surgery.

According to the literature reviewed, there are several valid techniques when it comes to OVD removal: the first method would be OVD aspiration from the AC by subtle and sudden taps on the IOL surface [15,16]. The second method is the "Rock and Roll" technique further developed into "Modified Rock and Roll technique". It consists on inducing a tilt of the IOL by lightly pushing it with the I/A probe posteriorly and creating a circular motion of the IOL at the same time. The third method is the aspiration of OVD by positioning the I/A probe behind the IOL [4,17]. This maneuver involves the potential risk of entrapment of the posterior capsule and its subsequent rupture.

It has been described and it's accepted that the material the IOL is made of can influence on the technique chosen to remove OVD [10,11]. According to Auffard, et al.'s published studies, certain OVD substances adhere more to some IOLs

depending on its composition. For instance, Healon 5 adheres more to acrylic IOLs with a hydrophobic surface. Nonetheless, no literature was found about the behaviour of OVD during the phase of aspiration related to plate-haptic IOL, as we did in our study.

It has been suggested that the remaining intracapsular OVD can also be associated with postoperative capsular blocks. Although recent studies shows that capsular blocks can be also significantly influenced by the axial length and the type of IOL used [18], laboratory examination of the retrolental fluid has found viscoelastic material [19]. Some patients experience spontaneous resolution [20] but most of them require posterior and peripheral anterior YAG capsulotomy [21].

Patients with postoperative capsular block show an unexpected myopic shift [22]. Following the same reasoning, we could deduce (no evidence) that eyes which retain retrolental OVD (free of capsular block) could displace the IOL anteriorly and therefore, show refractive changes in the postoperative early phases. According to our results changes in IOP and distance between the endothelium and the anterior surface of the IOL along the first 6 weeks after the surgery were not affected by the technique used.

However, in this study the statistical power was insufficient to analyse the differences between groups related to displacement of the IOL after surgery. There was a greater change in the group where the OVD was not removed by inserting the probe behind the IOL and statistical significance was almost reached ($P= 0.057$). Perhaps with a greater number of cases it could have happened. In addition, the change in the spherical equivalent at six weeks was greater in the same group, although, in this case, without approaching statistical significance. Nevertheless, the measured difference (0.07mm) does not appear to be clinically relevant.

Both techniques were proven to be equally safe. During the study no technique-related complication was observed, none of the patients presented compromise of the posterior capsule secondary to I/A entrapment. The authors have not found specific scientific evidence for rupture of the posterior capsule during these maneuver. However, the possibility of rupture of the posterior capsule by the I/A probe is a well-known fact [23,24].

The main weakness of this study was the lack of clear visualization of OVD after completing I/A OVD aspiration. Besides, a longer follow-up period would be necessary in order to assess late capsular block, capsular opacification, or potential increased risk of chronic endophthalmitis. A more numerous sample would have been useful to confirm results.

Based on the results we obtained, we can conclude that, OVD material can be removed from the eye by only aspirating from the centre of the AC at the end of the surgery when a plate-haptic IOL has been implanted. Remaining OVD behind the lens do not produce rise in IOP, refractive changes, or modification of the IOL position after surgery in a 6 weeks long follow-up.



Additional information

The article has been presented previously at the 15th ESCRS Winter Meeting Istanbul, Turkey.

There was not conflict of interest in the design and performance of this study.

This study has been conducted according to the World Medical Association Declaration of Helsinki.

Ethical Committee: code 18/313. San Juan University Hospital. Alicante, Spain.

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