

# Systematized Technique for Viscoelastic Material Aspiration in Phacoemulsification Surgery (Zebra Technique)

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**How to cite this paper:** Conciani, M., de Carvalho Rocha Moura, J., Filho, E.A., Serracabassa, P.D. and Tannous, M. (2026) Systematized Technique for Viscoelastic Material Aspiration in Phacoemulsification Surgery (Zebra Technique). *Open Journal of Ophthalmology*, 16, 166-175.

<https://doi.org/10.4236/ojoph.2026.162016>

**Received:** January 7, 2026

**Accepted:** May 10, 2026

**Published:** May 13, 2026

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## Abstract

Phacoemulsification is one of the most widely performed surgeries in the world. Although it has several complications reported in the literature, it is considered a safe procedure with low complication rates. This is mainly due to the development and systematization of surgical techniques, combined with growing experience in the field. Previous studies have reported that the main factor related to increased intraocular pressure in the early post-operative period is the presence of viscoelastic in the anterior chamber. The aim of this study is to describe a systematized technique for aspirating ophthalmic viscosurgical devices (OVD) in phacoemulsification and to evaluate its impact on post-operative intraocular pressure. We used a case-control design, comparing 2 groups of patients, the case group in which surgery was performed using the technique described and the control group with those who did not use the technique. This study aims to help prevent complications and improve post-operative results in cataract surgery.

## Keywords

Phacoemulsification, Viscoelastic, Intraocular Pressure

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## 1. Introduction

Phacoemulsification is currently one of the most performed surgical procedures globally and this number is expected to continue to grow, in line with the increase and ageing of the population, as well as improved access to healthcare in developing countries.

The advancement and systematization of surgical techniques and technology,

combined with growing experience in the field, have made cataract surgery a safe procedure with low complication rates. One of the most common and early post-operative complications is increased intraocular pressure [1]-[3].

Ophthalmic Viscosurgical Devices (OVD) play an important role in anterior segment surgery, and especially in cataract surgery. We know that the permanence of this intraocular material can lead to some complications, a phase that many experienced surgeons or those in training pay little attention to, considering that the surgery is already over and that this phase does not require such attention [4] [5].

OVD is normally used to protect and create space in phacoemulsification cataract surgery, especially at the beginning, to fill the anterior chamber for capsulorhexis. The anterior chamber is filled again for fracture and achievement of the nucleus, then to fill the capsular bag and anterior chamber for implantation of the intraocular lens [6]. After implantation and positioning of the intraocular lens comes the phase of aspirating the viscoelastic material [6] [7].

The retention of this intraocular material brings a series of complications, such as a peak increase in intraocular pressure (IOP) in the post-operative period, which can increase the inflammatory process. Some articles even mention an association with toxic anterior segment syndrome (TASS), and there are reports that it can evolve into post-operative capsular bag distension syndrome [8]-[10].

## 2. Objectives

- General Objective: To describe and evaluate the impact of systematic viscoelastic aspiration on IOP in the immediate post-operative period of cataract surgery.
- **Specific Objectives:**
  - 1) To describe the viscoelastic aspiration technique used.
  - 2) To compare IOP in the immediate post-operative period (in the first 24 hours) between the case and control groups.
  - 3) To identify clinical factors associated with significant variations in IOP after surgery.
  - 4) To evaluate and prevent complications related to ophthalmic viscosurgical devices.

## 3. Methodology

### 3.1. Study Design

A cross-sectional, retrospective, case-control study was conducted in the cataract sector of the Ophthalmology Medical Residency Program at the University of Santo Amaro - UNISA. The study involved patients who underwent phacoemulsification by the same surgeon between March and October 2024.

### 3.2. Population and Sample

The sample consisted of 32 patients who underwent phacoemulsification. The pa-

tients were randomized and divided into two groups of 16 patients.

**Case Group:** Patients in whom systematic aspiration of the viscoelastic was performed at the end of the surgery, according to the technique described in the study protocol.

**Control Group:** Patients who did not use the viscoelastic aspiration technique, with standard removal of viscoelastic at the end of the surgery.

### 3.3. Inclusion Criteria

- Patients diagnosed with senile cataract.
- Patients undergoing phacoemulsification surgery.
- Patients who agreed to participate in the study and signed the informed consent form.
- Uncomplicated surgeries.

### 3.4. Exclusion Criteria

- Patients with a history of ocular surgery, including intravitreal injections.
- Patients diagnosed with ocular conditions such as corneal dystrophies, ocular hypertension, glaucoma, retinopathy, pigment dispersion, and pseudoexfoliation.
- Patients with idiosyncrasies that suggested a non-direct surgery or with a higher probability of complications (lack of cooperation, poor mydriasis, concomitant limbal incisions).
- Patients who were not followed up in the immediate post-operative period.
- Patients with serious intraoperative complications (such as posterior capsule rupture).

### 3.5. Preoperative

During the preoperative evaluation of each patient included in the study, data such as age, sex and history of previous diseases were recorded, especially ocular conditions that could serve as exclusion criteria. Patients underwent a complete ophthalmological examination, which included anamnesis, biomicroscopy, cataract classification by LOCS III and funduscopy in mydriasis. IOP measurement was performed with a Goldmann tonometer after instillation of anesthetic eye drops (OXINEST<sup>®</sup>, Cristália Lab) and Sodium Fluorescein 1% (Ophthalmos<sup>®</sup>).

For pupillary dilation before surgery, three consecutive instillations of 1% tropicamide (Mydriacyl, Alcon<sup>®</sup>) and 10% phenylephrine (Allergan<sup>®</sup>) were performed at ten-minute intervals, one hour before the procedure. All patients were treated with instillations of 1.67% povidone for disinfection. All phacoemulsification procedures were performed by a single surgeon.

### 3.6. Phacoemulsification with Intraocular Lens Implantation

Cataract surgeries were performed using the following standard surgical technique: asepsis and antisepsis, peribulbar block with 2 ml of 2% lidocaine (Cris-

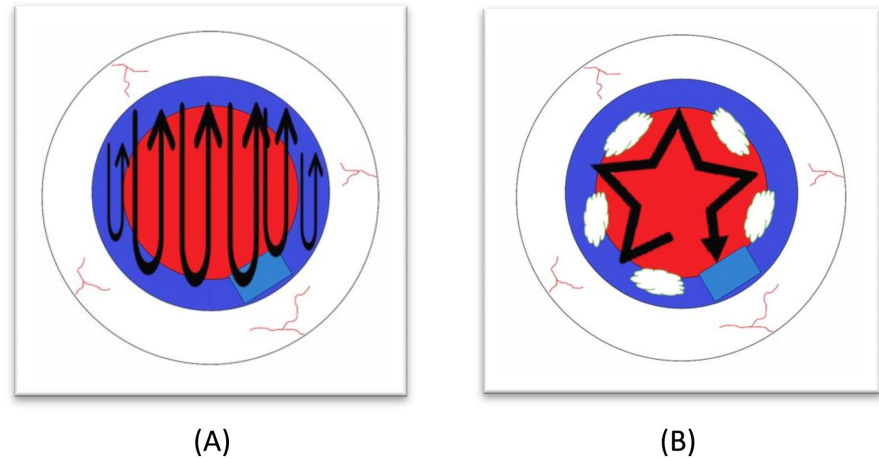
tália®) + 2 ml of 0.75% bupivacaine (Cristália®), insertion of sterile fields, 2.75 mm incision in self-sealing clear cornea; use of 0.1% trypan blue Ophthalmos®, use of 4% methylcellulose (Ophthalmos®) for filling the CA, accessory incision, continuous circular capsulorhexis; hydrodissection and hydrodelineation, injection of 2% methylcellulose (Ophthalmos®), use of the VERITAS® Johnson & Johnson Vision Care Inc phacoemulsifier, fracture with the phaco-chop technique, phacoemulsification and aspiration of the nucleus and epinucleus, aspiration of cortical remains using the Odous® coaxial Irrigation and aspiration handpiece. Filling of the capsular bag and anterior chamber with 2% methylcellulose, a three-piece foldable monofocal IOL (Sensar AR40e, Johnson & Johnson Vision Care Inc) was implanted with an appropriate injector, inside the capsular bag.

The viscoelastic was removed with two techniques, the patients were randomisation in two groups, **group 1** using the “systematized aspiration technique” described and **group 2** not using the technique. The implanted IOL was centered with the patient looking at the direct illumination of the surgical microscope, using intracameral Vigamox (Alcon®), and the surgery was completed with hydration of the incisions with balanced saline solution and instillation of topical Vigadexa (Alcon®).

Patients were instructed to use moxifloxacin 0.5% and dexamethasone 0.1% eye drops 6 times a day with progressive regression of instillations over thirty days.

#### 4. Systematic Viscoelastic Aspiration Technique (Case Group)

Viscoelastic aspiration is performed after implantation of the IOL in the capsular bag. The aspiration of the material should be conducted gently, trying not to cause trauma to the anterior segment [11]-[15]. A coaxial I/A probe coupled to the phacoemulsifier is used. The procedure begins in the capsular bag, over the lens, seeking to remove as much OVD as possible from the anterior part of the eye, displacing and slightly tilting the IOL with the tip of the probe. Small, sudden touches on the lens are performed both horizontally and vertically, as well as controlled partial decompressions to cause a discreet collapse of the anterior chamber (AC) and force the evacuation of the remaining OVD attached posteriorly to the lens. The irrigation should not be allowed to travel between the anterior capsule and the iris due to the risk of misdirection. After removing the material from the capsular bag, we move on to removing it from the AC. A sequence of vertical and/or horizontal linear movements is performed with the probe, starting near the chamber angle, traveling to the other end and returning to the starting point, repeatedly until the entire AC is covered. The outward route of the irrigation orifice should be kept facing upwards and the return route should be kept facing the aspiration route. This technique seeks to first remove the viscoelastic adhesion with the power of irrigation and, upon return, perform the complete removal with aspiration. Check if there is any remaining material at the end of the procedure. (See **Figure 1(A)** and **Figure 1(B)**)



**Figure 1.** (A): Sistematic, (B): Non sistematic.

## 5. Results

The study included 32 patients divided equally into 2 groups; all surgeries occurred in 2024 and were performed by the same surgeon (M.C) in the ophthalmology department of the University of Santo Amaro (São Paulo, Brazil).

All analyses were performed using the statistical software R Core Team (2018) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Inferential analysis was performed using statistical tests to test whether the pre (PRE) and post (POST) times differ in relation to the (distribution or mean of) the variable of interest and to compare their evolution. To do this, we first performed the Shapiro-Wilk Normality Test to determine whether the numerical variable has a Normal distribution at a statistical significance of 5%. In cases where the variable presented Normal distribution at a statistical significance of 5% ( $p > 0.05$ ), we performed the Parametric Test. On the other hand, if the variable did not present Normal distribution at a statistical significance of 5% ( $p < 0.05$ ), the Non-Parametric Test was performed.

A predominance of female patients was observed in both groups, with 9 women and 7 men in the case group and 11 women and 5 men in the control group (See **Table 1**).

**Table 1.** Frequency of the variables group and sex in the sample ( $p = 0.716$ ).

	Female	Male	Total
Case	9 (56.2%)	7 (43.8%)	16 (50%)
Control	11 (68.8%)	5 (31.2%)	16 (50%)
Total	20 (62.5%)	12 (37.5%)	32 (100%)

Initially, we present below the descriptive statistics of the numerical variable of the observations in each category of the categorical variable (See **Table 2** and **Table 3**).

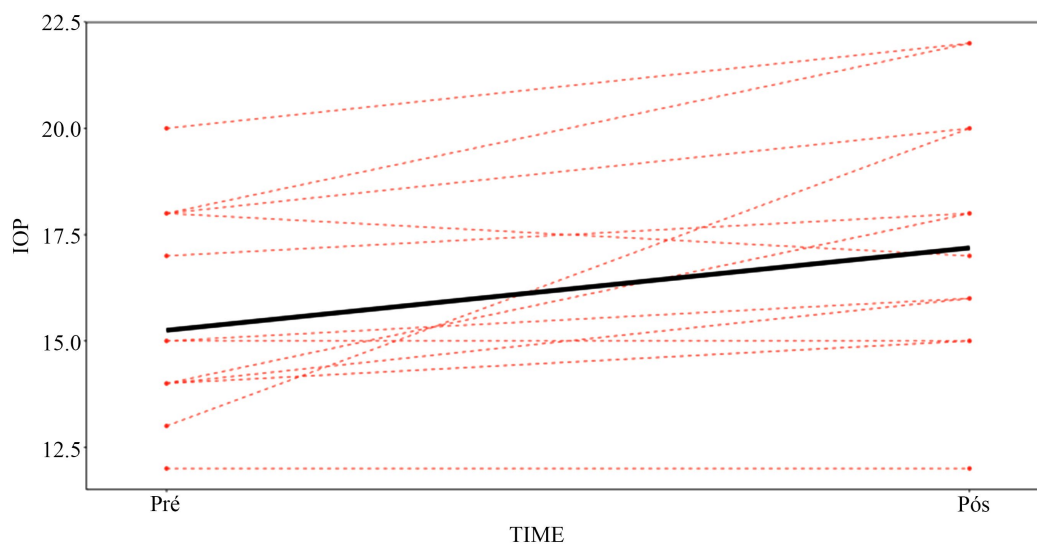
**Table 2.** Descriptive statistics of the IOP variable (Pre) by the group variable in the sample ( $p = 0.798$ ).

	N	Mean	SD	CI Low	CI High	Minimum	1st Quartile	Median	3rd Quartile	Maximum
<b>Case</b>	16.0	15.2	2.2	14.2	16.3	12.0	14.0	14.0	17.2	20.0
<b>Control</b>	16.0	15.0	3.2	13.5	16.5	9.0	13.0	15.5	18.0	20.0

**Table 3.** Descriptive statistics of the IOP variable (Post) 24 hours by the group variable in the sample ( $p = 0.816$ ).

	N	Mean	SD	CI Low	CI High	Minimum	1st Quartile	Median	3rd Quartile	Maximum
<b>Case</b>	16.0	17.2	2.8	15.8	18.5	12.0	15.0	16.5	18.5	22.0
<b>Control</b>	16.0	17.5	4.5	15.3	19.7	10.0	13.8	18.0	20.5	25.0

Then, the study of the evolution of the variables of interest over time was carried out for each group, separately. Therefore, for each group and for each variable, Descriptive and Inferential Analysis was carried out in order to study the difference between the value of the variable in the post time 24 hours (POST) and pre time (PRE) (See **Figure 2** and **Table 4**).

**Figure 2.** (Case Group): Profile graph of the IOP variable.**Table 4.** (Case Group): Descriptive statistics of the 24 hours post-pre difference of the IOP variable in the case group ( $p = 0.001$ ; Paired t-Test).

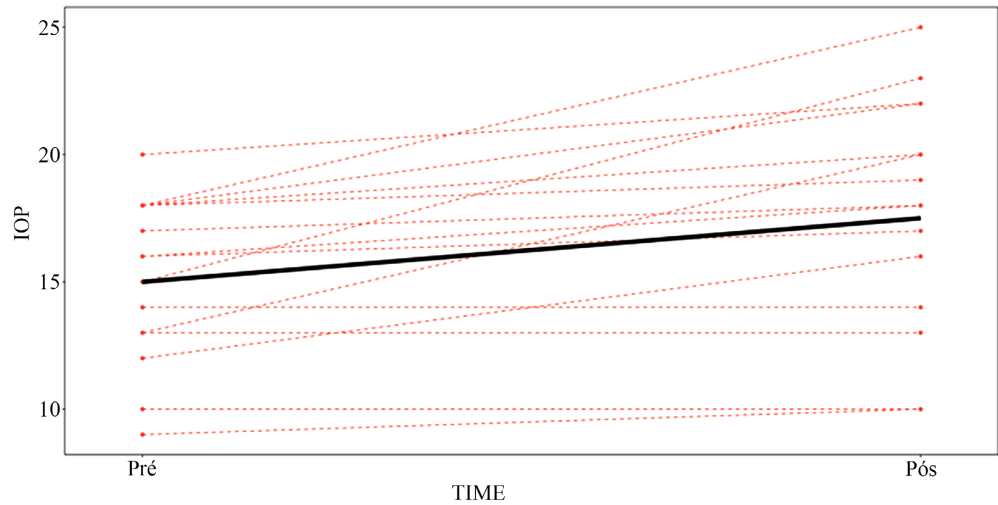
N	Mean	SD	CI Low	CI High	Minimum	1st Quartile	Median	3rd Quartile	Maximum
16.0	1.9	2.0	1.0	2.9	-1.0	1.0	1.5	2.5	7.0

The profile graph shows the evolution of the variable over time. The thickest line that appears on the graph represents the mean of the numerical variable in the pre- and post-periods. The other thinner lines each represent the value of the numerical variable of an observation of the sample in the pre (PRE) and post (POST) periods of each patient.

We can see that for both groups, the mean evolution is positive, that is, for both

groups, the mean IOP is higher after the intervention. Furthermore, for both groups, at a statistical significance level of 5%, we concluded that there is an influence of the intervention on the IOP variable over time (pre and post) (See **Figure 3**).

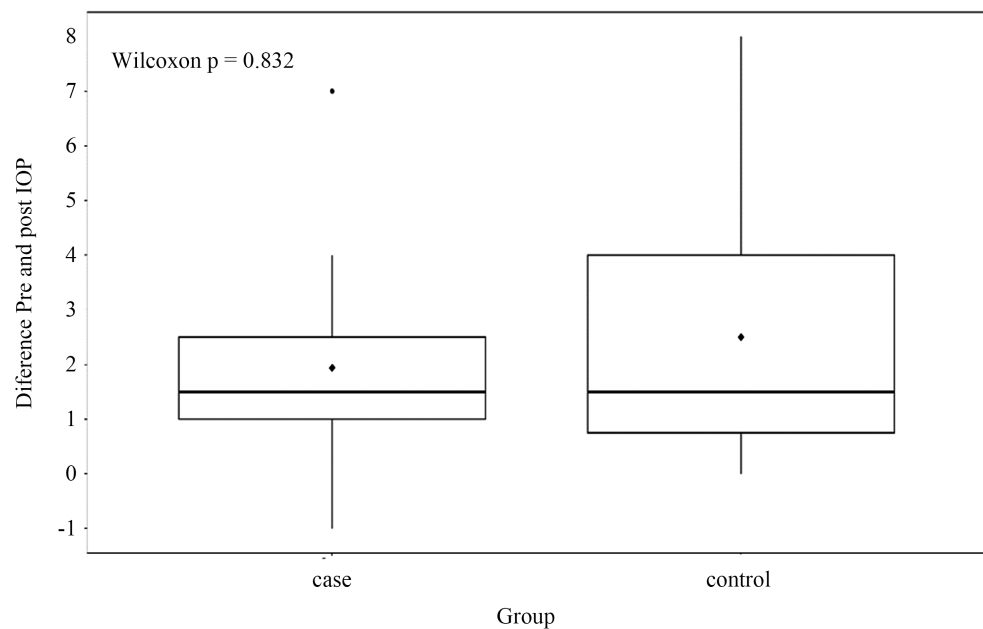
Finally, we compared the groups in relation to the evolution of a variable of interest (IOP) from pre to post (See **Figure 4** and **Table 5**).



**Figure 3.** (Control Group): Profile graph of the IOP variable.

**Table 5.** (Control Group): Descriptive statistics of the Post-Pre difference of the IOP variable ( $p = 0.002$ ; Paired Wilcoxon Test).

N	Mean	SD	CI Low	CI High	Minimum	1st Quartile	Median	3rd Quartile	Maximum
16.0	2.5	2.7	1.2	3.8	0.0	0.8	1.5	4.0	8.0



**Figure 4.** Box-plot of the Post-Pre IOP Difference variable by the Group variable.

**Table 6.** Descriptive statistics of the post-pre IOP difference variable by the group variable in the sample ( $p = 0.832$ ).

	N	Mean	SD	CI Low	CI High	Minimum	1st Quartile	Median	3rd Quartile	Maximum
<b>Case</b>	16.0	1.9	2.0	1.0	2.9	-1.0	1.0	1.5	2.5	7.0
<b>Control</b>	16.0	2.5	2.7	1.2	3.8	0.0	0.8	1.5	4.0	8.0

We can see in **Table 6** that for both groups the mean difference is positive, that is, the IOP value increases after the intervention. Furthermore, among those in the case group, this mean is lower than that of the control group, and therefore, the mean increase is greater for the control group compared to the case group. Although there is this difference between the groups observed in the sample, at a statistical significance level of 5%, we cannot conclude that the groups differ in relation to the evolution of the IOP.

## 6. Discussion

OVDs are great allies of the ophthalmic surgeon in several steps of phacoemulsification. However, they are not without risks, therefore, we constantly seek to minimize possible repercussions caused by these materials by seeking complete removal at the end of the procedure.

Knowing that most patients undergoing phacoemulsification are elderly and have compromised blood supply to the optic nerve and retina, it is essential to be careful with hypertensive peaks in the immediate post-operative period, in order to reduce the risk of damage to these tissues and provide adequate recovery. According to the literature reviewed, there are few updated and valid techniques for OVD removal. The technique described in this study proved to be safe and to have satisfactory post-operative results. The mean increase in IOP was lower in the case group. However, in this study, statistical significance was insufficient to analyze the differences between the study groups in relation to the evolution of IOP.

The main limitation of this study was the limited sample of patients; in addition, a longer post-operative follow-up period would be interesting to evaluate other variables and possible long-term complications.

## 7. Conclusions

The interpretation of the data presented demonstrates that IOP increases in the immediate post-operative period of phacoemulsification, in agreement with data from previous studies. However, it did not reveal statistical differences in the evolution of IOP in relation to the different techniques applied in the study. The lack of difference may be related to the relatively small sample size.

Although no statistically significant differences were observed, the study describes a systematic technique for viscoelastic aspiration, a step that is no less important in phacoemulsification. It is suggested that future research be carried out in comparisons with other techniques, such as the “rock’n roll” technique described by Arshinoff, in addition to a study with a larger number of patients.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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