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Phacoemulsification Cataract Surgery without Viscoelastic Substance: Bianchi's Method

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Abstract

Life expectancy of the population increase and cataract development will affect all the people with aging. Cataract surgery, a worldwide performed procedure, evolves and progresses. However, different techniques exist, which could be selected for different cases. Any ideal technique should be safe, simple, fast, and easy to learn with good clinical outcome. This chapter will describe one technique to operate cataracts with those characteristics and to perform phacoemulsification cataract surgery without viscoelastic substance. Some advantages of this technique are related to avoiding viscoelastic potential problems, as postoperative intraocular pressure elevation or anterior chamber inflammation associated with viscoelastic. Moreover, a fundamental factor to remark is the difference between work into the anterior chamber with negative pressure or positive pressure. Because the anterior chamber is maintained by the balanced salt solution with the continuous irrigation without viscoelastic. Performing the capsulorhexis is easier. Other advantages are shorten surgical time, fewer economical cost, and potentially fewer complications. Some limitations are as follows: intraocular lens must be one piece foldable, and principally, patients with corneal endothelial pathology must be excluded. Tips, step-by-step surgery, recommendations, and evolution of the technique will be described, with the wish that many surgeons will try to perform Bianchi's method (bimanual, microincision phacoemulsification cataract surgery without viscoelastic substance) for your next patient.

Keywords: phacoemulsification, cataract surgery, viscoelastic, technique, cataract surgery complications

1. Introduction

The life expectancy is increasing every decade, and the lens of the eye decreases their optical quality over the years [1]. If we could live the number of years what is expected, everybody

will have cataracts and will need a cataract surgery. That is a fact. Cataracts are still a leading cause of moderate to severe visual impairment, even blindness worldwide [2–4]. Visual impairment caused by cataract leads to not only an economic loss but also the impaired quality of life [5]. However, cataract is easily treatable by surgery [6]. On the other hand, there are different studies trying to find how cataracts could be prevented [7–9]. In the future, cataractogenesis could be totally elucidated, and maybe cataract surgery will not be necessary. However, until today, the only way to resolve this problem is by a surgical procedure.

Science and technology improve ophthalmology performance to protect the sight. Today, a cataract surgery takes only a few minutes, with topical anesthesia, with sutureless, and with a very fast visual recovery. Moreover, cataract surgery research in this field progresses continuously. And it always is possible to improve for tomorrow what we are doing now. The chapter which I want to share with you is exactly about that: how we could improve cataract surgery technique, with the same surgical equipment usually employed.

I have begun performing cataract surgery since 22 years ago. When I learned to operate cataracts, extracapsular was the surgical technique of choice, without the aid of viscoelastic substance. Their use at those years was not extended widely. And surgeries went well. After that, phacoemulsification technology produces a revolution, improving surgical outcome. At the same time, the intraocular lens (IOL) industry grew up, as well as viscoelastic substances spread worldwide and were included as one necessary medical supply for the surgery. Viscoelastic substance appears to resolve a lot of problems, which could arise when the anterior chamber is opened [10, 11].

The anterior chamber space preservation is relevant to avoid endothelial complications [12]. If anterior chamber space is flattened, the iris could be damaged, the corneal endothelium could suffer, and all of the work inside the eye are riskier. New surgeon generation from developed countries learns to operate cataracts with phacoemulsification equipment using viscoelastic substance as the gold standard technique. And today, femtosecond laser technology is growing and possibly in a close future takes the place of phacoemulsification technique completely. However, more machines, more devices, and more medical supplies are increasing their final cost and not necessarily increasing their visual and refractive results over other techniques. Moreover, there are many surgeons around the world, in developing countries, where that sophisticated technology is not accessible. They help people without an expensive medical device and without viscoelastic substance and still perform cataract surgery by extracapsular technique [13]. The Blumenthal technique of manual small-incision cataract surgery (MSICS), with the help of anterior chamber maintainer, has been proven safe and effective, preventing endothelial cell loss during surgery [14, 15].

Why have I developed this technique to perform phacoemulsification cataract surgery without the aid of viscoelastic substance? After one scientific meeting in Vienna, Austria (European Society of Ophthalmology 2015), I was thinking about the way to decrease my surgery time, simplify the technique without increasing risk, and if possible improve my personal surgery outcome. There are published descriptions to avoid the use of viscoelastic substance during IOL implantation [16, 17] with good results. First, I began doing that and it was fine. However, I want to avoid the use of viscoelastic substance at all. Could capsulorhexis and hydrodissection have

been performed without viscoelastic substance safely during phacoemulsification technique? The answer is yes, and also, avoiding completely the use of viscoelastic substance, it could have relevant advantages, as I will describe in this chapter. I propose to myself to perform and develop phacoemulsification cataract surgery without viscoelastic substance. I will share my experience, my technique tips, indications, contraindications, and why today this is my first choice technique to perform cataract surgery.

2. Viscoelastic substance: advantages and problems

Since the 1970s, viscoelastic substance begins to progress, and today they are popular and indispensable for integral parts of intraocular surgery [18]. The main purpose for using viscoelastic substance in cataract surgery is to maintain a stable anterior chamber depth and protect the corneal endothelial cells from being damaged [11]. That decreases surgical complications and makes challenging cases easier. For example, there are cases called “intraoperative floppy iris syndrome,” which was associated with tamsulosin, a systemic α -1 blocker used to treat benign prostatic hypertrophy [19]. The clinical intraoperative triad of the syndrome consists of fluttering and billowing of the iris stroma caused by ordinary intraocular fluid currents, a propensity for iris prolapse through the phacoemulsification and/or side-port incisions, and progressive constriction of the pupil during surgery [19]. Also, viscoelastic substance is sometimes helpful to tamponade a posterior capsule rupture for subsequent IOL implantation [20] or to inject viscoelastic substance through a pars plana incision to elevate the nuclear pieces into the anterior chamber [21].

However, there are studies which describe problems related with viscoelastic substance. The IOP elevation by viscoelastic substances is caused by a reduction of aqueous outflow due to blockage of the trabecular meshwork where the fluids exit the eye, which was first published in 1990 [18] and later confirmed by other authors in vivo and in vitro [10, 22, 23]. Therefore, complete removal of viscoelastic substance is recommended after IOL implantation. The IOP elevation is usually transient, peaking at 4–7 h postoperatively and returning to baseline within several days, but the maximum IOP may exceed 30 mmHg. Therefore, careful monitoring of IOP and IOP-lowering therapy may be necessary, especially in patients with glaucoma who have a compromised outflow facility.

Flare or Tyndall effect could be postoperatively detected after cataract surgery, which in part is frequent, but in excess that could be the manifestation of “toxic anterior segment syndrome” (TASS) after cataract surgery, and viscoelastic substance could be associated with this [23, 24]. Also, an extra surgery time is necessary to introduce viscoelastic substance and to completely remove them from the anterior chamber, trying to avoid the problems previously described. Moreover, viscoelastic substance increases the final cost of the surgery. In conclusion, viscoelastic substances could help to perform a more secure surgery, especially in some cases, but also could be the cause of other problems, sometimes serious. Because of that, this work emphasizes and proposes a special technique to perform phacoemulsification cataract surgery without viscoelastic substance.

3. Bianchi's method: patient selection

As any surgical technique, specific indications and contraindications (inclusion/exclusion criteria) will be described, to choose the appropriate case or to exclude patients with high risk:

1. Include patients with cataracts classified as NO1–NC1 to NO4–NC4 according to the LOCS III classification (avoid NO5–NC5, NO6–NC6).
2. Exclude patients with less than 2000 endothelial cell count preoperative. Endothelial cells count evaluation is necessary to be included as a standard preoperative test, and it is advisable to perform as postoperative standard follow-up test.
3. Exclude patients with endothelial defects, *pseudoexfoliation*, posttraumatic cataracts, pupil synechiae or small pupil, uveitis, and/or previous vitreoretinal surgeries.
4. Include only patients programmed to implant foldable one-piece intraocular lens (IOL) models with injector.
5. Exclude patients when three-piece IOL models are programmed to implant. I do not recommend those kinds of IOLs for this procedure because their haptics are hard and the capsule could be broken.

4. Bianchi's method: technique description step by step

When a new surgical technique is presented, there are many questions to be answered. I will try to describe all of the details because I hope many surgeons worldwide probe it with success. One first question: will it be necessary to acquire new equipment, devices, and/or machines? The answer is no. The technique could be correctly performed with different standard phacoemulsification equipment, and any surgeon who perform phacoemulsification with viscoelastic technique could perform the Bianchi's method without viscoelastic substance. Hand positions and movements are similar to "microincision cataract surgery" (MICS). It is just necessary to get a micro-capsulorhexis forceps of 1.1 mm diameter, which must have the same diameter of the irrigation cannula. From standard surgical instruments usually employed to perform phacoemulsification, you will only need the irrigation cannula, but the aspiration cannula is not necessary. **Figure 1** shows the specific surgical tools.

Topical anesthesia must be performed as usual *and then*:

1. Two clear corneal incisions of 1.1 mm were performed with v-lance near the limbus. The first was at "2" o'clock and the second at "10" o'clock.
2. Immediately after the first incision was performed, the irrigation cannula (1.1 mm diameter) was introduced, the second incision was performed, and the micro-capsulorhexis forceps of 1.1 mm diameter was introduced. The size of the v-lance and the irrigation cannula must be the same to avoid leakage through the corneal incision.

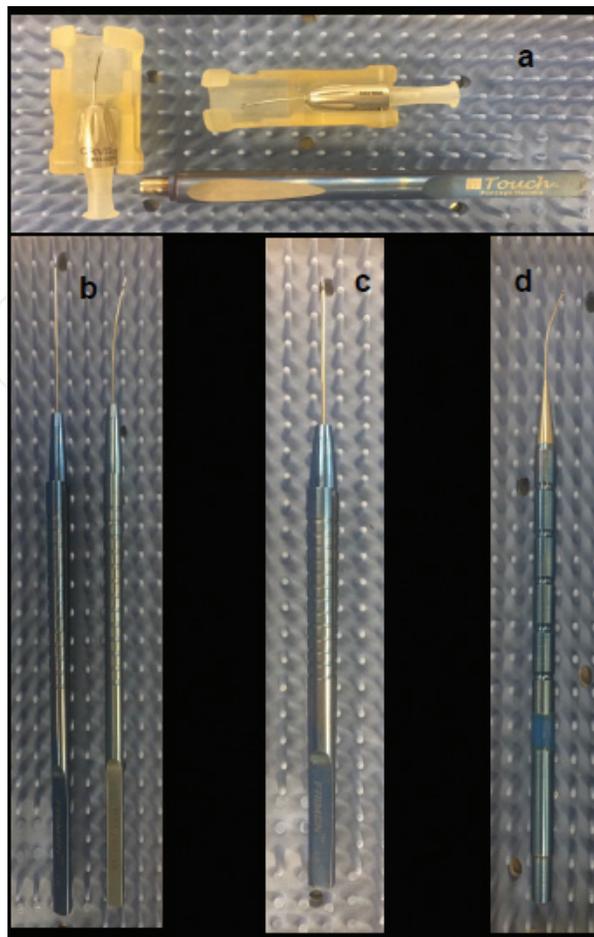


Figure 1. Surgical instruments necessary to perform Bianchi's method. (a) MST Touch Handle and 23g Micro-Holding Forceps for capsulorhexis; (b) Curve and straight Micro-Scissors; (c) capsulorhexis micro-forceps and (d) I/A irrigation cannula.

3. The irrigation bottle with balanced salt solution (BSS) must be elevated usually at 80–100 cm above the patient's head level, under continuous irrigation (no more, to avoid IOP increase), to obtain a deep and stable space in the anterior chamber. The irrigation cannula has two lateral vents, which let the BSS leave and move in a centripetal way, toward the equator. That means the liquid circulation is not against the endothelium; therefore, the endothelium is protected. For the learning curve, in the first case, it is recommended to put in the automatic or continuous way the irrigation mode of the phaco. This lets to maintain stable the anterior chamber automatically. With more experience, the surgeon can manage them with the phaco pedal.

This bimanual technique is suitable for right- or left-handed surgeons. The previous description is for right-handed surgeons. For left-handed surgeons, "2" o'clock incision is for micro-capsulorhexis and the cannula must be located at "10" o'clock incision.

4. Capsulorhexis was performed (**Figure 2**), while the liquid (BSS) circulation in the anterior chamber produces a positive pressure, which determines a stable and safe space to work. This is one of the most important points of the technique. It is easier to perform the

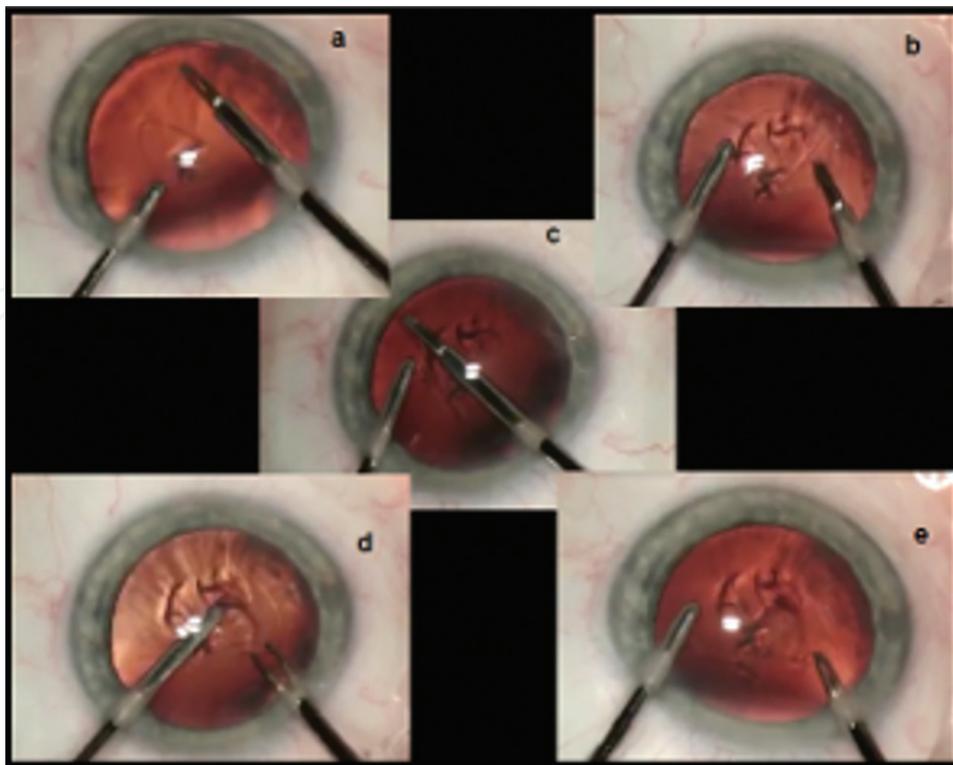


Figure 2. This figure shows from “a” to “e” the capsulorhexis procedure with continuous liquid circulation into the anterior chamber.

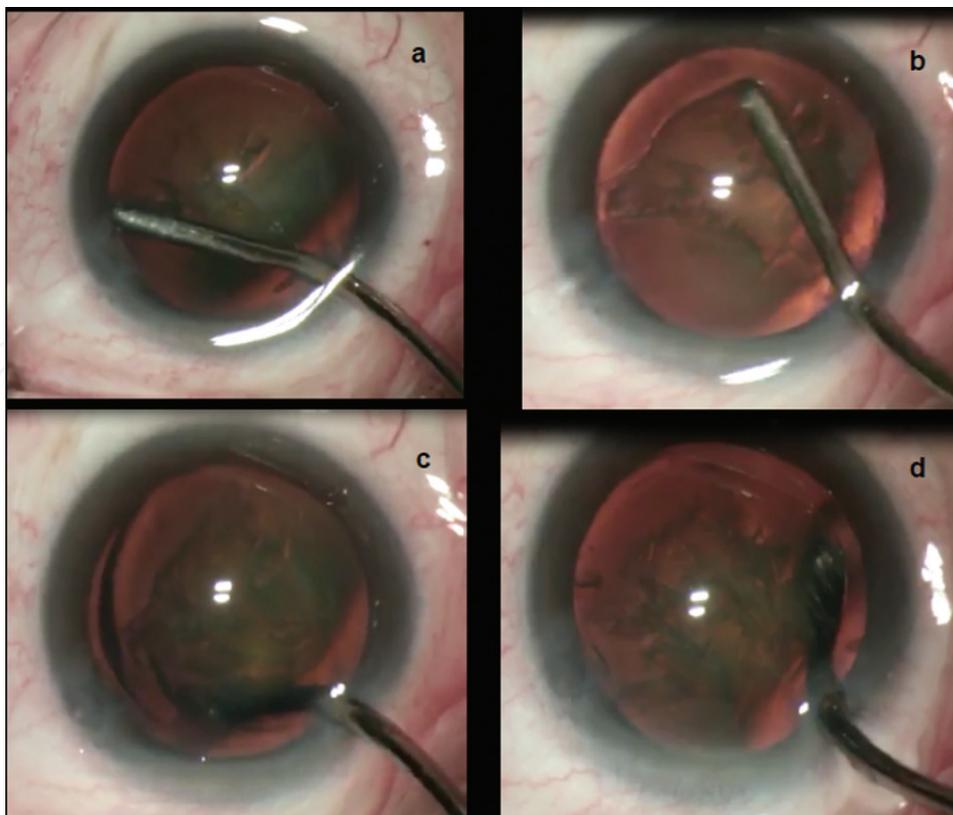


Figure 3. Hydrodissection step performed with the irrigation cannula and from “a” to “d” is possible to see the nucleus rotation.

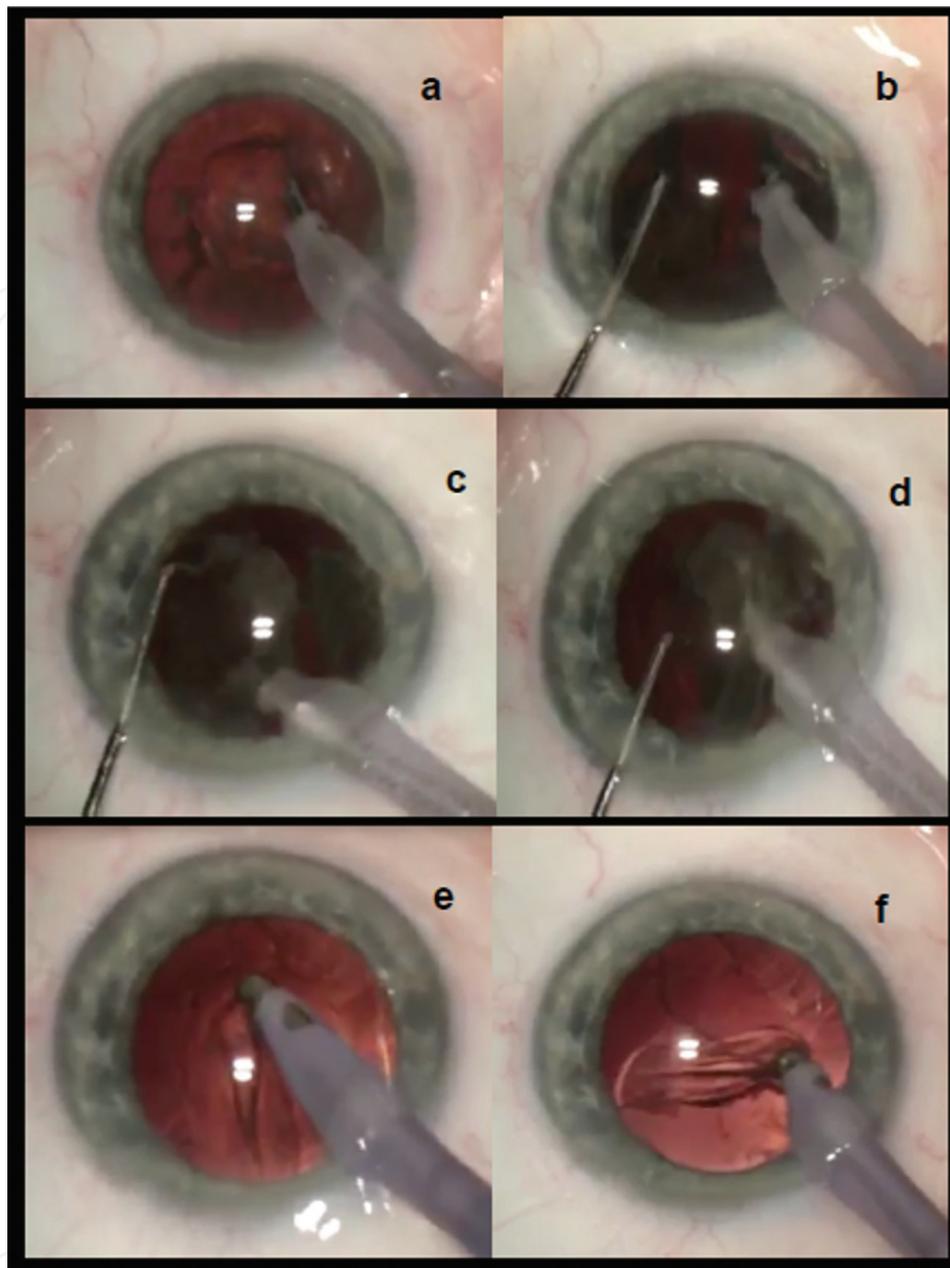


Figure 4. Phacoemulsification, aspiration, and mass extraction were performed as usual.

capsulorhexis under positive pressure than under negative pressure (as what happens with viscoelastic substance), because continuous irrigation flattens the anterior face of the lens. When you are working under positive pressure into the anterior chamber, it is very rare to have the problem of capsulorhexis rupture. In my experience, capsulorhexis failure was more frequent with viscoelastic substance than those cases performed without viscoelastic substance.

5. After that, hydrodissection was performed with the same irrigation cannula until a complete rotation of the nucleus was observed (**Figure 3**). Perform this step carefully, because if you push too much the nucleus, the zonula could be broken. However, it is not difficult to perform the hydrodissection: simply, let the irrigation cannula position below capsulorhexis, and the liquid diffuses around the nucleus to release it. Or sometimes, a

circular movement of the cannula could be performed to facilitate that the nucleus will be released from the epinucleus. Then, the rotation of the nucleus will easily occur.

6. Phacoemulsification, aspiration, and mass extractions: it will be performed without any difference from a standard procedure (**Figure 4**).
7. Next step: without removing the cannula, the second corneal incision must be increased (**Figure 5**) according to the phaco tip, for the IOL implantation (1.8 mm, 2.2 mm up to 2.8 mm or what the surgeon need) (**Figure 6**). Only foldable one-piece IOL models with injector could be used. Three pieces IOL models are not recommended for this procedure. When the intraocular lens cartridge was introduced through the incision, the anterior chamber could suffer a space reduction due to BSS outflow, but immediately after the IOL injection begins, liquid leakage stops, and the anterior chamber space is restored. The positive pressure expands the capsular bag, and then the IOL is placed with the cannula to help during the unfolding process to obtain the correct IOL position. Also, this procedure let the toric IOLs be easily rotated, if it was necessary. This is another advantage of this technique against standard technique with viscoelastic substance, because sometimes, after removing viscoelastics, toric IOLs could be displaced and are necessary to correct their position again, to obtain the exact location for astigmatism correction.

Finally, I usually inject an intracameral antibiotic (cefuroxime) and the surgery concludes. Most of the surgeries were performed between 4 and 5 min or 6 and 7 min for harder cataracts.

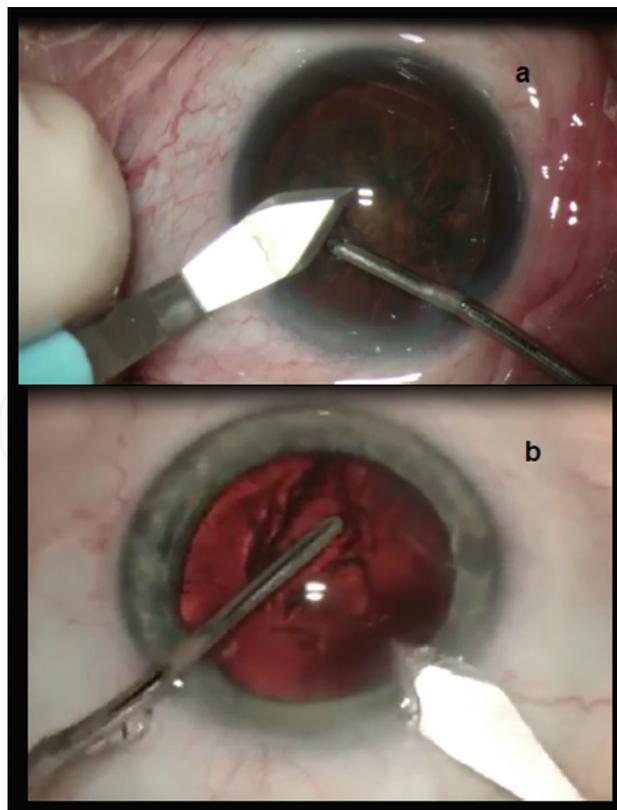


Figure 5. This figure shows the second corneal incision enlargement.

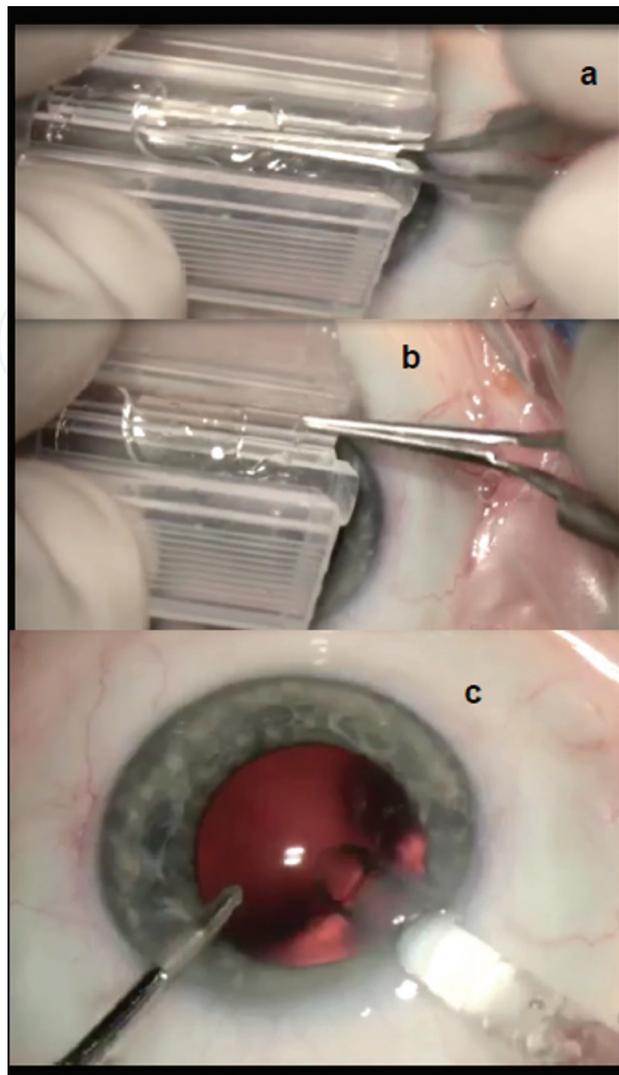


Figure 6. One-piece intraocular lens is placed in an injected.

5. Is this technique secure?

Performing cataract surgery without viscoelastic substances seems to be dangerous for the corneal endothelial tissue. However, with the surgical steps previously described, it is true? To evaluate and control this matter, since my beginning with this technique (July 2015) and after 1500 operated cases, all of the patients are still followed with endothelial cell count and central corneal thickness evaluation (always at the preoperative time and, then, at least 6 months post-op with endothelial cell count follow-up).

A prospective comparative study is ongoing, to evaluate clinical outcomes and complications between both techniques: phacoemulsification with and without viscoelastic substance by Bianchi's method. I can advance some data from this study, as a brief preliminary report. The patient's age was 45–91 years old; none of them has suffered intraoperative or postoperative

complications as capsular bag rupture, IOL implantation problems, expulsive hemorrhage, IOP elevation, TASS, and/or endophthalmitis. All of the patients improve their visual acuity. Endothelial cell count and central corneal thickness were compared between patients operated with and without viscoelastic substance, and nonstatistical significant difference was found between both groups. The surgical time with Bianchi's method is between 4 and 5 min (7 min maximum) and for standard phacoemulsification with viscoelastic is 8–10 min (for this study, the surgeon was *German Bianchi MD* for all of the procedures). Why is the surgical time shorter? Because an extra time is needed to insert and completely remove the injected viscoelastic substance. Besides a prolonged operation time, which per se increases overall operation risks and complications, viscoelastic substance removal can immediately affect safety issues. Also, an increased irrigation-aspiration time might also be responsible for endothelial cell loss due to the aspiration trauma. The use of a viscoelastic substance can have side effects and may cause endothelial damage as well.

Even though it is an ongoing study, preliminary data plus the experience of 2 years doing this technique with good outcomes let me confirm that it is secure, fast, and simple. Now, it is my first choice to perform cataract surgery.

I have started to teach this technique to the ophthalmic residents of the clinic where I work, and they told me "it is not difficult" and also the learning curve is fast. However, some colleagues previously told me: "well, is easy for you... but not for everybody!." No, today I can confirm that the Bianchi's method to perform cataract surgery without viscoelastic substances is easy, for any ophthalmic surgeon who used to perform phacoemulsification technique or MICS.

6. Is there another experience where surgeons try to avoid the use of viscoelastic substance?

Schulze et al. [25] avoid their use, only during IOL implantation, without finding difference in endothelial cell loss. Oksuz et al. [26] described a technique without VS to perform capsulorhexis, but they use it after hydrodissection and for the IOL implantation. Finally, they aspirated it from the anterior chamber.

In the past, Wright et al. [13] compare their results of small-incision extracapsular cataract surgery using the anterior chamber maintainer without viscoelastic substance, and they finally show that the magnitude and range of the endothelial cell losses associated with this technique are significantly greater than those described following phacoemulsification. Because of that, these authors finally recommend the use of VS for this extracapsular procedure.

But in 2008, Sallet [27] described a phacoemulsification cataract surgery technique completely performed without VS, where he found no difference in their clinical outcome comparing it with 50 patients operated with VS. However, Galan [28] previously performed a similar technique with 1.6 mm corneal incision and enlargement to 3.0 mm for IOL implantation with less success rate than Sallet G, which Sallet considered could be due to the narrower incisions performed by him of 1.2 and 2.6 mm for IOL implantation. The technique described in this

work proposes two corneal microincision, which is 1.1 wide and the enlargement of one of those to 2.2–2.8 mm according to the phacoemulsification tip (Sallet G open 2.6 mm). Small corneal incisions could be in part the key to obtain better surgical results. Another difference with the technique described by Sallet G is about hydrodissection: in the present technique, it is performed by the irrigation cannula.

7. Economical surgery cost

This new technique is not more expensive. In fact, it is more economic, because it is not necessary to buy viscoelastic substances. In the country where I live, the final cost of the surgery increases US\$75 per procedure when viscoelastic substance (I use DisCoVisc[®]) is necessary.

However, as in this chapter was described, there are many patients where viscoelastic substances are not necessary: not only because it increases the surgery cost but moreover because they could be a potential problem, which disrupts the surgical outcome.

8. Final recommendations

As it was mentioned at the beginning of this chapter, lifetime expectancy increases as well as ocular tissues grow older. Our eyes are not prepared for the last years that we are living. Cataracts appear and the possibility to replace them with an IOL let many people stay able to keep their sight and quality of life. Moreover, the improvements in the surgical techniques, device, equipment, and tools let today to resolve high orders of refractive problems with the IOL implantation (with or without removing the lens). The procedure to implant an IOL into the eye is short, simple, and secure. But it is always possible to improve and adequate techniques to different environments.

The technique described in this work was presented in the XXXV Congress of the European Society of Cataract & Refractive Surgeons (ESCRS Lisbon 2017) at the Video Awards Session. There is a mini-review published in September 2017 [29]. Also, the video of the technique could be showed in <https://vimeo.com/212631783>. If you are a cataract ophthalmic surgeon, try this technique, and you will decrease complications, surgery time, and surgery cost with a better postoperative recovery. Remember the indication and contraindication, choose the right patient, and go ahead.

Below is the list of advantages and limitation.

Advantages:

1. Avoid complications related with viscoelastic (IOP elevation, TASS) and corneal endothelial damage during the viscoelastic substance aspiration.
2. Perform a fast surgery (4–5 min usually, 6–7 min at maximum).
3. Work all the time under positive pressure in the anterior chamber; this let the capsulorhexis becomes easily performed.

4. Short learning curve: usually new cataract surgeons only learn to operate phacoemulsification cataract surgery with viscoelastic substances. I'm not against viscoelastic substance, which is really useful for some cases, although, for other cases, it could be possible to perform a safe procedure without viscoelastic substance, moreover, with "extra" advantages!
5. Surgery cost: the final cost of the surgery decreases for the patient, because you do not need an extra medical supply (you do not need to buy viscoelastic substance for each surgery). And as my scrub nurses happily told me, they also prefer it. Why? Micro-capsulorhexis forceps cleaning and maintenance are more easy when I use BSS than viscoelastic substances. And also, that increases the lifespan of my surgical tool. For all of those reasons, it decreases the total surgical economical cost.
6. One more advantage: you do not need a third-hand incision.

What are the limitations or contraindications?

1. Avoid "hard" cataracts.
2. Avoid three-piece IOL.
3. The technique is not recommended for patients with endothelial corneal pathology, pseudoexfoliation syndrome, traumatic cataracts, and/or history of previous vitreoretinal surgery. However, in those cases, the standard phacoemulsification procedure will also increase the surgical risk. Endothelial corneal transplantation or complete perforated corneal transplant could be necessary at the end because of bullous pseudophakic keratopathy and the consequent corneal edema.
4. Endothelial cell count is a mandatory preoperative study, and I recommend follow-up 6 months after surgery. I know that some places do not have an endothelial cell counter analyzer, but it is a study which I think is relevant to perform not only the Bianchi's method, moreover, for every patient who will need a cataract surgery. Today the people have great expectative about their refractive surgical outcome after cataract surgery, and if a patient has an endothelial problem and if it was possible to have an objective data about it, the surgeon could decrease patient's expectative and explain to him which could be his specific surgical risk, before performing the surgery. I emphasize this point. It is a really important issue to prevent legal problems.
5. If capsulorhexis goes wrong, always convert to viscoelastic standard technique.
6. Hydrodissection must be performed without pressing over the posterior capsule to avoid rupture.
7. Doing the IOL implantation should be obtained in a well expanded anterior chamber, but if not, use viscoelastic substance.

In summary, a bimanual phacoemulsification microincision cataract surgery could be performed without the aid of viscoelastic substance, decreasing their economical cost during 5–7 min. The technique is easy to learn and potentially with fewer complications, which must

be scientifically demonstrated in a prospective study (which is an ongoing study), and even better in a multicentric study to confirm that this technique is efficient and reproducible for different ophthalmic surgeons.

And finally, to end this chapter, I want to share with you a little story.

My professor was Dr. Hugo Dionisio Nano, one of the most important ophthalmologists in Argentina, with international recognition around the world. Dr. Nano, with his age of 88 years old, usually goes to his clinics, goes to scientific meetings, and still is an active "ophthalmology teacher" for many colleagues. In 2016, he needed a cataract surgery and chose me as his surgeon, a great honor and a great challenge for me. For his first eye, I have performed the standard phacoemulsification cataract surgery, with viscoelastic substance. Surgery went fine with no complications. However, he had a moderate postoperative inflammation and intraocular pressure rise, which resolved a few days later. One week after, I chose to operate his second eye without viscoelastic substance (Bianchi's method), and he did not have any postoperative problem. This is one anecdote I know, but I hope with this chapter, I could give you enough scientific information and technical tips to encourage you and try "Bianchi's method" in your next cataract surgery.

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