

Increasing rim height depth for safe femtosecond laser-assisted capsulotomy in intumescent white cataracts with liquified cortex

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Dear Editor,

Continuous curvilinear capsulorhexis is an essential part of modern cataract surgery, as it safely enables phacoemulsification procedures and permits a stable intraocular lens (IOL) bag implantation. Intumescent white cataracts with a hard nucleus and a liquefied cortex have been categorized as type I. When, in this type of cataract, the anterior capsule is opened with a cystotome the liquified cortex exits to the anterior chamber causing rapid lens decompression, nuclear displacement and sometimes capsulorhexis tearing^[1-2] a feared complication that largely compromises the results of the surgery.

The study was conducted in accordance with the principles of the Declaration of Helsinki. The informed consent was obtained from the subjects.

Recently, two automatic anterior capsulotomy techniques have been introduced: the selective laser capsulotomy (SLC) and the femtosecond laser capsulotomy (FLC)^[3]. Both offer a technical advantage over classical manual capsulorhexis: they are performed in a closed anterior chamber (AC) and may thus have lower rates of anterior capsule tearing^[3].

However, it is still controversial whether FLC is superior to SLC or to manual capsulorhexis in cataract surgery and specially in complicated cases^[3-4]. FLC has been documented to produce a better-centered capsulotomy and may thus cause less IOL decentration and tilt than manual capsulorhexis^[5] but may produce a less resistant capsulorhexis edge^[3-4] and higher incidence of capsular tears, although these facts remain controversial^[4,6-7].

FLC is a very quick automatic procedure that may take between 1 and 3s and is performed normally using standard treatment parameters recommended by every laser system^[3-4,8]. Although these parameters are set before the procedure, they can be modified to increase the success of complete capsulotomies and there is scarce literature on how they can be modified to improve the surgical results. One of the parameters that is set for FLC is capsulotomy rim height depth (CRHD). This parameter determines the height of the cylinder (with a definite diameter and rim height depth which incorporates the anterior capsule and anterior and posterior safety margins) that corresponds to the site where the laser shots are applied during FLC.

In this letter we emphasize the importance of the CRHD settings for FLC in intumescent white cataracts. We present the results obtained in a case series that included the first five patients with hypermature white cataract with liquified cortex that were operated consecutively by the same surgeon (Gegúndez Fernández JA) using FLC. The etiology was: senile in four cases and Fuch's uveitis syndrome in one case (Figure 1C). The patients were dilated with 3 consecutive drops of tropicamide (colirio de 1% tropicamida[®], Alcon) and topic anesthesia was attained with 3 consecutive eyedrops containing a combination of 1% tetracaine and 4% oxibuprocaine (Colirio anestésico doble[®], Alcon). A curved lens appplanation suction ring was docked onto the ocular surface, bathed in saline solution. The femtosecond laser was then used only for capsulotomy, but the rest of the surgery was performed manually to avoid introducing more variables. FLC was carried out using the Victus Femtosecond Laser Platform (Bausch and Lomb,

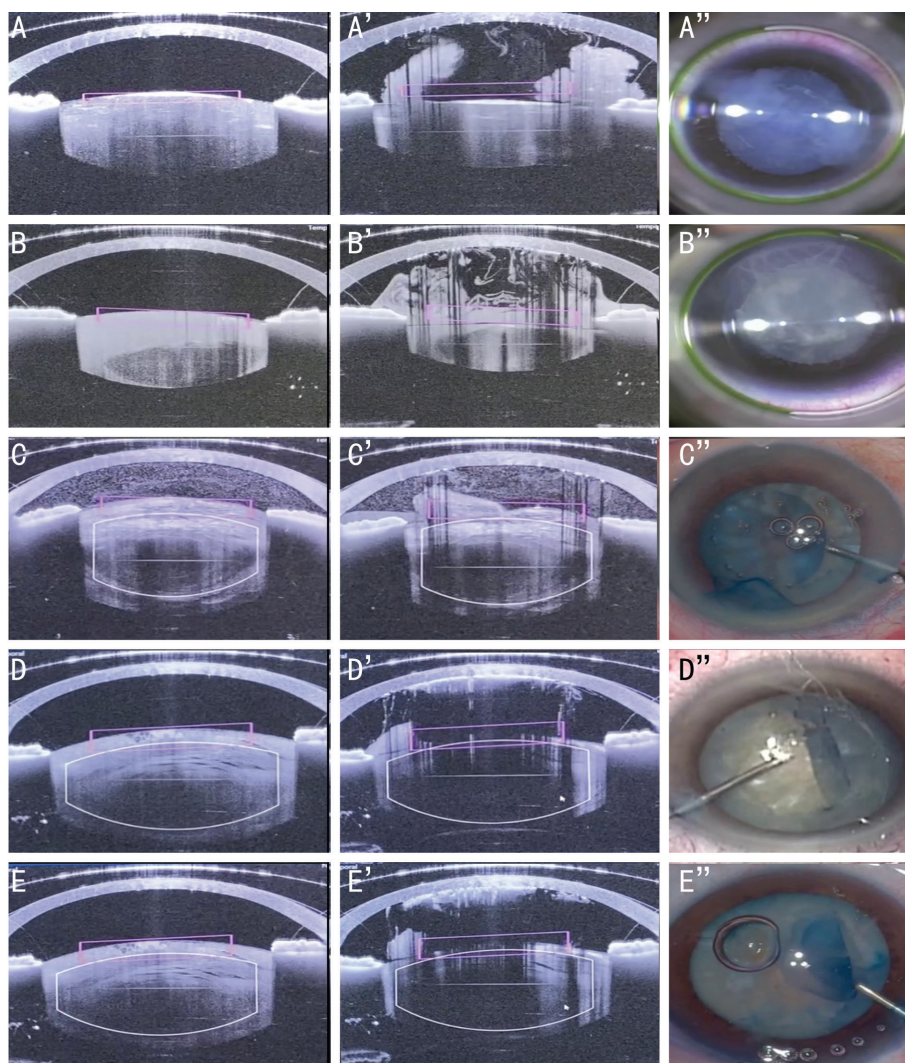


Figure 1 Selected intraoperative live SS-OCT images of the 5 consecutive cases. Images taken before the capsulotomy (A-E) and the images post capsulotomy of the same patients (A'-E'). The CRHD cylinder appears as a rectangle on the anterior surface of the crystalline lens (A-E'). Passage of liquified cortex to the anterior chamber, anterior movement of the posterior capsule and posterior movement of the anterior capsule occurred after capsulotomy, causing the CRHD cylinder to lose contact with the crystalline lens in some places. Intraoperative images (A''-E'') of the same eyes during FLC (A'', B'') or after FLC and trypan blue application, when saline irrigation permits the visualization of incomplete (C'', D'') or complete capsulotomies (E''). CRDH: Capsulotomy rim height depth.

Rochester, NY, USA) that has an in-built REALEYEZ swept-source optical coherence tomography (SS-OCT) Software that allows live visualization of the procedure (Figure 1).

The laser was set to perform a 5.3 mm diameter anterior capsulotomy using the following predetermined recommended parameters: pulse frequency 80 KHz, pulse duration 400-550fs, line spacing of 4.0 μm , spot spacing of 6.0 μm and pulse energy of 6.40 μJ . We used a 5.3 capsulorhexis diameter because animal studies have suggested this size as ideal for various reasons, including capsular strength^[3-4]. The CRHD was set at 500 μm in the first patient and at increasing heights in the following patients.

When initiating the FLC we observed in all patients that as soon as the anterior capsule was disrupted by the first laser shots, intralenticular bubbles formed that exited from the lens

to the AC, accompanied by milky liquefied cortex (Figure 1). During the completion of the FLC, we observed a posterior displacement of the central anterior capsule and loss of volume of the capsular bag. As a consequence of these movements, in the first four patients the cylinder that represents the CRHD that can be observed in the live OCT as a rectangle (Figure 1), lost contact with the anterior capsule in some areas and therefore the subsequent laser shots did not reach the anterior capsule. Because we observed these phenomena in the first patient in which we were using a CRHD of 500 μm , in the following consecutive patients, we increased the CRHD to 600, 700, 800, and 1000 μm and only in the last case the CRHD cylinder did not lose contact with the anterior capsule and therefore laser shots reached the anterior capsule in all the circumference of the capsulotomy (Figure 1).

After FLC, two clear corneal incisions were made manually and a solution of 0.06% trypan blue (Blue Color Caps® Bausch and Lomb) was injected into the AC to visualize the anterior capsule. In the first four cases, in which the CRHD cylinder lost contact with the anterior capsule, we found an incomplete capsulorhexis with capsular tags in the inferior, nasal and/or temporal regions (Figure 1). After application of dispersive viscoelastic (Viscoat®, Alcon), manual completion of the capsulorhexis with forceps was carried out uneventfully in these four patients. Then phacoemulsification (Stellaris™, Bausch and Lomb) and IOL implantation were carried out in all patients.

In type I white hypermature cataracts with liquefied cortex, the most difficult surgical step is performing a complete capsulorhexis, as the reported rates of incomplete manual capsulorhexis may represent up to 28% in intumescent white cataracts and only 0.8%-4.0% in normal cataracts^[2]. However, the rate of capsular tears may be higher with FLC than with manual capsulorhexis^[6-7]. Furthermore, it is not known whether FLC is superior to manual capsulorhexis in complicated cases^[3,5-7]. We think that FLC has some advantages that may prevent the development of capsular tears in these cases, namely: 1) it is performed with a closed anterior chamber; 2) is executed at a high intraocular pressure and therefore the pressure difference between the aqueous humor and the intumescent lens is smaller; and 3) the settings of the different parameters can be modified and optimize the procedure.

FLC uses individual pulses applied to laser spots that do not overlap because they are normally set at 5-6 µm separation^[3]. This separation between spots could be responsible of leaving uncut capsular material between them^[4], thus producing an incomplete capsulorhexis. However, it has been documented that these capsular uncuts, named tags or bridges after FLC in most instances can be easily liberated manually^[3], and only very rarely produce radial capsular tears^[6-7], and this has been the case in our patients.

The completeness of the FLC could also be influenced by factors other than the separation of the laser spots, such as eye movements during the procedure or the type of the cataract: white hypermature cataracts with liquefied cortex^[2,4] often show incomplete capsulotomies after FLC, as in our first four patients. We show that this occurs because as soon as the first capsular opening is made, the liquid cortex exits the capsule producing a posterior displacement of the anterior capsule that exits the field of action of the laser^[2-3,9]. However, we also

document that this can be avoided increasing the CRHD up to 1000 µm. We have applied this height in our subsequent cases with excellent results.

In conclusion, we document that FLC is a safe technique in white hypermature cataracts with liquefied cortex but that in this procedure it is important, in order to obtain a complete capsulotomy, to increase the CRHD setting prior to capsulorhexis.

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