Capsulorhexis Marker: A New Tool for Accurate Sizing and Centration of Capsulorhexis in Animal Model

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Abstract

Purpose: To describe a new instrument (capsulorhexis marker) to optimize the size, shape, and centration of the capsulorhexis during phacoemulsification.

Setting: Wet Lab. sponsored by Alcon laboratories.

Methods: 10 goats eyes were prepared for the procedure. A specially designed capsulorhexis marker with a circular part having an inner diameter of 5.5mm was used. The lower edge of the circular part of the marker was stained by viscot surgical marker and applied to stain the anterior capsule in well defined circular fashion.

Results: There was no encountered difficulty in introduction or removal of the marker from all eyes. In 8 eyes there was a well centered rounded mark which was adequately stained.

Conclusions: The capsulorhexis marker is an instrument designed to help in accurate sizing and to perform a perfectly centered round capsulorhexis.

Key Words: Capsulorhexis marker – Centration – Animal.

Introduction

Since surgeons transitioned from intracapsular to extracapsular cataract extraction, a well-constructed capsulotomy has been the key to a successful procedure. Since the phacoemulsification era began, capsulorhexis has become the standard capsulotomy technique. Anterior capsulorhexis can be performed using 26 G bent needle cystitome or capsulorhexis forceps [1, 2].

With a free-hand method, it is not easy to create a perfectly sized anterior capsulorhexis that is also perfectly centered relative to the pupil or the limbus. The anterior capsulorhexis obtained is usually continuous but may be noncurvilinear, varying from renal to heart shaped and in some cases, it may be discontinuous [3]. Moreover, the introduction of multifocal intraocular lenses (IOLS) increased the need for a better surgical performance and precision. Many investigators tried to design new tools for better sizing and shape of the capsulorhexis for example diathermy rhexis [4] and vitrectorhexis [5].

Certain styles of capsule forceps have been designed with laser marks to help surgeons to produce various capsulotomy diameters. However, these forceps are limited in their ability to provide a diameter reference in the horizontal meridian parallel to the phacoemulsification incision [6].

The aim of this study was to describe a new instrument to optimize the size, shape, and centration of the capsulorhexis during phacoemulsification. Up to our knowledge, this is the first published article in literature describing capsulorhexis marker staining the anterior capsule.

Material and Methods

This study was performed in a wet Lab. sponsored by Alcon laboratories. The wet lab is fully equipped with high resolution microscopes, disposable instruments and good video recording. A capsulorhexis marker was specially designed for this study. It is made of stainless steel. It is formed of a handle attached to a circular part having an inner diameter of 5.5mm and 1mm height (Fig. 1). 10 goat’s eyes were prepared for the procedure. In each eye a 3mm limbal corneal tunnel was performed, and then vesicocoeastic material was injected into the anterior chamber. Afterwards, the wound was widened to 6mm to allow easy introduction of the instrument. In 5 eyes, the lower edge of the circular part of the capsulorhexis marker was stained by viscot surgical marker pen (gentian violet dye). In another 5 eyes, the lower edge of
the circular part of the capsulorhexis marker was stained by viscot surgical marker pad (Vismark, gentian violet pad, Viscot medical, IIC). This pad is a useful tool to stain corneal markers during keratoplasty procedures. The capsulorhexis marker was introduced into the anterior chamber (Fig. 2) and applied to the anterior capsule for few seconds without pressure to avoid zonular stress. Special care for centration of the capsulorhexis marker in relation to the pupil was done. The marker was then removed from the eye and assessment of the mark was done as regards centration and degree of staining of the anterior capsule (Fig. 3).

**Results**

There was no encountered difficulty in introduction or removal of the marker from all eyes. In all cases, the lower edge of the circular part of the capsulorhexis marker was adequately stained. There was no significant difference in the degree of capsular staining by using either the viscoat marker pen or marker pad. In the first two eyes, the mark was not clear due to sliding of the marker on the surface of the anterior capsule; this resulted in spread of the stain leading to a diffuse mark on the surface. In all other cases, special attention was done so as not to slide the marker on the surface of the anterior capsule with precise marking technique to avoid this complication. This resulted in well centered rounded mark which was adequately stained, precise, clear enough to guide the surgeon to perform 5.5mm capsulorhexis.

**Discussion**

A well-constructed capsulorhexis is the foundation of complication-free phacoemulsification and IOL surgery. Ophthalmic surgical dyes have become valuable tools and are now widely used for both anterior and posterior segment indications. In this study we presented the capsulorhexis marker which is applied directly on the anterior capsule in order to help in better centration and sizing of the capsulorhexis. Moreover, it may guide phacoemulsification beginners and shorten their learning curve for this crucial step in modern cataract surgery.

Today’s demanding refractive results require a well centered perfectly circular capsulorhexis that slightly overlaps the IOL’s optic. This construction is important for achieving the so-called capsular shrink-wrap effect during the postoperative period. A 360° overlapping capsular edge creates a capsular bend, which acts as a barrier against proliferating lens epithelial cells and thus significantly delays the onset of posterior capsular opacification (PCO) [7-9]. The overlap also sets the anteroposterior positioning of the IOL, which prevents capsular fibrosis from shifting the lens optic forward and creating an unwanted late refractive shift. Moreover, with a perfectly circular capsulorhexis, any contraction of the anterior capsule (i.e, phimosis) will be symmetrical, so late in-the-bag decentration of the optic is prevented. The aspheric optics of the AcrySof IQ Restor lenses (Alcon Laboratories, Inc., Fort Worth, TX) and Tecnis Multifocal IOL (Abbott Medical Optics Inc., Santa Ana, CA) tolerate very little decentration [10]. Also, if the capsulorhexis is too small, it can result in glare,
halos and night driving problems with a diffractive multifocal IOL, such as the ReSTOR. Capsular phimosis is more pronounced with small capsulotomies [11,12]. A small capsular opening makes surgery more difficult and places greater stress on the anterior capsule during nuclear division or quadrant removal. Furthermore, a smaller capsular opening can obscure peripheral retinal visibility and treatment. A capsulorhexis with a 5.5-mm diameter is usually ideal.

Many investigators have tried to improve the predictability of size, shape and centration of capsulorhexis. Wallace [6] performed a study to make a central corneal mark with a 6.0mm optical zone marker, previously used for radial keratotomy, (with the center of the optical zone as the central visual axis) as the patient fixates on the light of the microscope. He performed the capsulorhexis in the usual way with the intention of leaving the borders of the capsulotomy inside the capsulotomy diameter mark. However, this technique has many disadvantages: As corneal curvatures are not uniform between patients, a different mark size would be required for each patient to achieve the correct capsulorhexis size. Moreover, use of this marker incorrectly implies that corneal curvature remains constant after the incisions are made [3]. Also, the corneal plane and the anterior capsule plane must be parallel with a focal plane of the operating microscope to avoid parallax errors and the surgeon may confuse the corneal mark with the anterior capsule rim at the time of IOL implantation [13].

Tassignon et al. [3] designed a 0.25mm ring-shaped caliper with an internal diameter of 5.0mm or 6.0mm (Morcher GmbH). The caliper is made of polyethylene methacrylate. The caliper ring is inserted using 2 forceps or a lens manipulator. After it is inserted, the ring is gently pushed on top of the anterior capsule with additional Healon GV. A small opening is made in the center of the capsule, which serves as the starting point for the capsulorhexis. The surgeon then carefully follows the internal border of the ring caliper. However, this technique is not precise as the ring is not fixed on the anterior surface of the capsule and thus any movement of the ring will affect the size, shape and centration of the capsulorhexis.

A promising technological solution involves overlaying a reference ring on the surgeon’s view through the microscope. Carl Zeiss Meditec, Inc., developed an interface module that adjusts the size of the ring appropriately with microscope magnification while keeping it centered within the limbus using real-time eye tracking. Ophthalmic surgeons have such technology on excimer lasers, why not for surgical microscopes as well? [14]. Finally, several companies are developing femtosecond technologies to perform the capsulorhexis.

**Drawbacks and future:**

In this study, we used a simple primitive prototype that needs a large corneal incision (6mm) to be introduced inside the eye. We considered this the first step in our research and we are looking forward to change the material of the marker to form memory ring able to be introduced and extracted inside the eye and become ergonomically feasible. However, it can be used as such in cases of combined cataract extraction with keratoplasty. We studied the toxicity of the gentian violet dye used with the marker on the ocular structure in a rabbit’s model. Results were promising and will be published soon.

**Conclusion:**

Capsulorhexis marker is an instrument designed to optimize the size, shape, and centration of the capsulorhexis during phacoemulsification by impressing a circular pattern on the anterior capsule to guide the surgeon in creating a 5.5- to 6.0-mm diameter capsulorhexis. More refinement of the instrument is needed to be able to use it in human.

**References**


