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Case report

Modified bandage-contact-lens used as a guide-marker for performing continuous-curvilinear-capsulorhexis by a first-year-post-graduate-ophthalmology-resident

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ABSTRACT

Purpose: To define the use of modified bandage-contact-lens as a guide-marker for performing continuous-curvilinear-capsulorhexis by a first-year-post-graduate-ophthalmology-resident.

Observation: Phacoemulsification has now become the standard cataract surgery in which anterior capsulorhexis is the first and most crucial step. A perfect capsulorhexis is difficult to learn and even more difficult to master with a steep learning curve when performed free-hand especially by a first-year post-graduate ophthalmology-resident. There is paucity of simple, single-use, easily portable, cost-effective and affordable devices designed especially for performing CCCs in a safe and reproducible way.

In our technique, the bandage contact lens (BCL) is trephined using a 6mm corneal trephine. After topical or peribulbar block (as the case may be), the 6mm-guide-marker (trephined BCL) is placed on the cornea. The CCC is then completed using the edge of the contact-lens as a guide for CCC.

Conclusion: AND IMPORTANCE: CCC with contact-lens-guide-marker is expected to yield better results in carrying out the procedure more accurately being closer to the target in terms of size, circularity and centration as compared to contact-lens-unassisted conventional CCC. This would eventually facilitate better surgical outcomes and we recommend this to be applied as the standard protocol for first-year post-graduate ophthalmology-resident performing the surgery.

1. Introduction

Phacoemulsification has now become the standard cataract surgery in which anterior capsulorhexis is the first and most essential step. Continuous curvilinear capsulorhexis (CCC) can be done using conventional capsulotome or Utrata rhexis forceps. Since India is a developing country with meagre resources that are seldom freely available, it is generally done using a 26-G needle fashioned capsulotome. An ideal capsulorhexis[1] should be 5.5mm circular without any ragged edges since it defines the Effective Lens Position (ELP) and facilitates the 0.5mm capsule-IOL overlap which is paramount for post-operative stable central intraocular-lens (IOL) position and resultant aberration-free acuity. A perfect capsulorhexis is difficult to learn and even more difficult to master with a steep learning curve when performed free-hand especially by a first-year post-graduate ophthalmology-resident.

Improper capsulorhexis may cause intraoperative complications like ragged edges and anterior capsular tears leading to posterior capsular rents whereas post-operatively it may lead to IOL decentration syndromes and resultant deficit in intended aberration-free acuity. Advanced methods like Femtosecond laser assisted cataract surgery (FLACS) and Intra-operative operative-microscope-assisted Toric-markers like VERION have been proved to be more precise, more accurate, more controlled and more reproducible but are much more expensive and not easily available freely in developing countries like India.

We hereby describe a simple contact-lens rhexis-marker-guided capsulorhexis to provide an answer to these deficiencies in surgical ophthalmology in developing countries.

2. Technique

The bandage contact lens (BCL) is trephined using a 6mm corneal

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trephine. The BCL used in this study was the Bausch + Lomb PureVision2 Balafilcon A (©2020 Bausch + Lomb,USA) with aspheric optics, base curve 8.6mm, lens diameter 14mm, optical zone 9.00mm @ −0.50D and central thickness 0.07mm for the optical zone.

Intraoperatively, the anterior capsule was stained through the side-port using 0.06% trypan blue. After topical or peribulbar block (as the case may be), the 6mm-guide-marker (trephined BCL) is placed on the cornea (Fig. 1). The CCC is then completed using the edge of the contact-lens as a guide for CCC (Fig. 2).

The use of a 26-G bent needle to perform capsulorhexis is not universal and many surgeons employ the Utrata rexis-forceps for the CCC; however the instrument used for CCC has no bearing on the use of our trephined-contact-lens guide-marker as it does not affect nor modify the site or configuration of the side-port or the main-port entry. Infact this would be one of the most unobtrusive and yet well-defined learning aids of CCC to the post-graduate resident.

The primary pre-requisite for successful completion of CCC is maintenance of the intraocular pressure or rather maintenance of the anterior chamber. Thus if additional viscoelastic is needed, the trephined-contact-lens guide-marker would not need to be moved. However in the event of its inadvertent, direct or indirect, movement or misplacement, there are 2 ways to establish centration and repositioning. Firstly, in a co-axial retroilluminated system, the globe is positioned with the help of a Lims's forceps such that all four Purkinje images of the eye superimpose into a single one and then light reflex from the contact lens surface is alligned with this single fused Purkinje image of the eye. Secondly, the centre of the contact lens is marked with the help of a 30-G needle using the hole in the centre of the trephine well. The centre of the cornea is marked using an RK-marker and the two marks are aligned to achieve the desired intended centration of our trephined-contact-lens guide-marker.

3. Results

We have used this technique in 20 cases of uncomplicated phacoemulsification (10 cases with topical anaesthesia using 0.5% proparacaine and 10 cases with peribulbar anaesthesia using 2% lignocaine). We selected 20 ophthalmology residents to use this technique in their 5th solo surgery. The rationale behind selecting their 5th surgery in the evaluation of this technique is the fact that by the 5th surgery, the resident would be well aware of the importance of a well-centralised round circular rhexis, the difficulty level in achieveing this, the

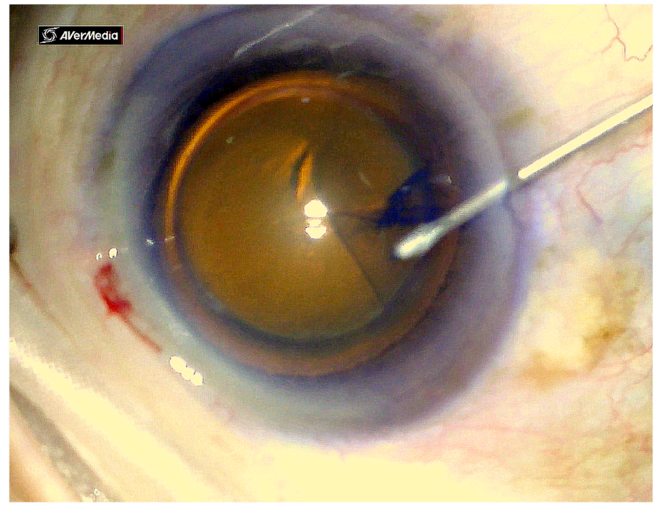

Fig. 2. Screen capture of the technique depicting the use of the trephined-contact-lens guide-marker where the post-graduate resident can be seen following mark so as to proceed with the CCC.

learning curve associated with it and yet not be so proficient enough unassisted that a guide-mark would definitely be of objectively-observable-benefit to him/her.

The technique was subjectively evaluated by each resident on a scale of 0–10 of how likely he/she would be interested in using the trephined-contact-lens as a guide-marker for his/her next surgery. 14 residents expressed a likelihood score 10, 4 residents scored it 9 and 2 residents stated that they were 8/10 times likely to use it again in their next surgery. Average score that the technique achieved was 9.6/10.

The technique was objectively evaluated using 3 variables:

1. TIME: Time taken for rhexis completion (calculated from the time the first nick was made on the anterior capsule using the 26-G bent needle/Utrata rhexis-forceps till the time the rhexis was completed and the instrument was removed from the intracameral space). Mean time taken was 78.6 ± 3.54 secs.
2. CONFORMITY: The rhexis area was divided into 8 quadrants of 45° each and the number of quadrants where the actual rhexis margin did not conform to the intended desired rhexis margin (i.e the

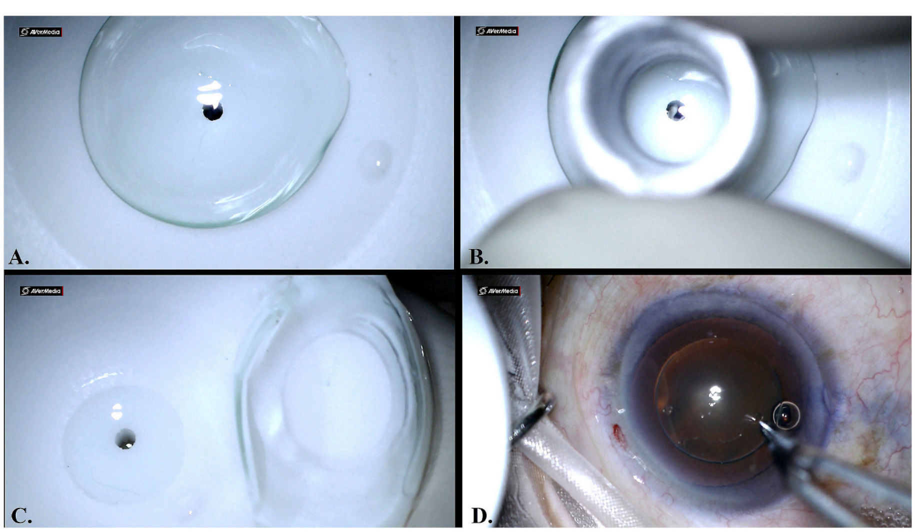

Fig. 1. (A) Bandage contact lens centered in the trephination well before using the 6mm trephine; (B) Bandage contact lens being trephined using a 6mm trephine; (C) The trephined-contact-lens guide-marker of diaeter 6mm and the remnant contact-lens-rim both being shown in profile; (D) The trephined-contact-lens guide-marker after being placed on the cornea prior to CCC.

trephined-contact-lens guide-marker) were evaluated. Mean quadrants not conformed were 1.35 but there was no incidence of rhexis extention and all surgeries were completed uneventfully.

3. REPOSITION: The number of times the trephined-contact-lens guide-marker needed to be repositioned after its inadvertent, direct or indirect, movement or misplacement, were noted and there were a total of 7 times this needed to be done i.e. 7/20 = 35% repositioning rate.

Post-operatively, the round, central, circular CCC was verified on dilated slit-lamp retro-illumination.

4. Discussion

Cataract surgery methods are being modified and improved with the advent of technological developments. The most significant modifications have been the preferred surgical technique for cataract surgery from intracapsular cataract extraction (ICCE) in the 1960s and 1970s, to extracapsular cataract extraction (ECCE) in the 1980s and 1990s, to the present technique of sutureless small-incision phacoemulsification surgery with injectable intraocular lens (IOL) implantation. The most significant step common to all these techniques is making a perfectly sized, circular capsulotomy in the anterior lens capsule. Anterior capsulotomy was invented by Jacques Daviel[2] in 1747 but it was a very primitive technique then. Vogt[3] used a toothed forceps to grasp and shear away the anterior capsule while Kelman[4] invented the "Christmas tree" approach in 1968. The can-opener technique, that superceeded these methods, had ragged margins leading to posterior capsular tears. Finally the continuous curvilinear capsulorhexis (CCC) was described by.

Gimbel and Neuhann in 19,80[5], which is the gold standard technique of anterior caosulotomy now.

Review of literature search yielded similar markers that had been devised for perfecting the size and shape of the capsulorhexis ranging from cheap-and-crude capsulotomy markers to mark the corneal surface to PMMA and silicone rings that can be placed on the anterior lens capsule to the more advanced digital-markerless-systems incorporated into the operating microscope such as the Callisto (Carl Zeiss Meditec AG) and the Verion Image-Guided System (Alcon Laboratories, Inc.).

Tassignon et al.[6] described a 0.25 mm ring with 5.0mm or 6.0mm internal diameter of 5.0 mm or 6.0 mm that is gently placed over the anterior capsule with Healon GV and the surgeon could use the internal border as a guide marker for capsulorhexis. Hassaballa AM. and Osman AA.[7] used a specially designed stainless steel marker with inner diameter 5.5mm to demarcate the anterior capsule in goat's eyes with either gentian violet using a surgical marking pen (Viscot Medical, East Hanover, NJ) or gentian violet using a surgical marker pad (Vismark®, Viscot Medical). The most important drawback of this method was that the incision size had to be increased to 6 mm to introduce the marker into the eye. Rey de Faria MA et al.[8] described a marker on similar lines that was made using two separate surgical-stainless-steel pieces, each piece having a distal semicircular ring of 5.0 mm diameter. Grooves on the lower face were stained with methylene blue and were then used to mark the anterior capsule. The Morcher Ring Caliper (Morcher; distributed in the United States by FCI Ophthalmics) was a 0.25mm thick ring of temporary polymer having an internal diameter of 5.0 mm or 6.0 mm and could be used as a guide marker for capsulorhexis in similar fashion. Suarez E. and Alkadi T. developed the Verus ring[9] that could be introduced in the anterior chamber through a 2.2 mm incision and placed over the anterior capsule with dispersive ophthalmic visco-surgical device (OVD). They described capsulorhexis using the inner edge of the Verus ring similar to "ripping a piece of paper against an overlying ruler". Lee JH., Lee YE., Joo C studied the clinical results of the open ring PMMA guider assisted capsulorhexis (ORGC)[10] in cataract surgery. It was introduced into the anterior chamber similar to CTR (capsule tension ring) placement and capsulorhexis performed using the inner edge as guidemarker. The WallaceCapsulotomy diameter marker[11] were similar to radial keratotomy markers where the lower edge of the instruments were stained with dye and impregnated it over the cornea. Carl Zeiss Meditec Inc developed an interface module that adjusted the size of the guide marker in accordance with microscope magnification as well as kept it centered within the limbus using real-time eye tracking. The "Verion Image guided system" Alcon Laboratories, Inc. and "Callisto Eye Computed Assisted Cataract Surgery" (Carl Zeiss Meditec AG) are Image-Guided-Systems (IGS) that projected a circular guide mark of desirable adjustable size on the anterior capsule intraoperatively. Plasma blade capsulotomy[12] utilises plasma technology (electrosurgical base unit attached to a Fugo blade tip) to create a sharp incision into the anterior capsule. Its main advantages are that it causes no collateral tissue damage when performed under the cover of OVD. Precision Pulse Capsulotomy (PPC)/Zepto capsulotomy[13] system uses a nonlaser, highly focused, fast, multipulse, low-energy discharge which provides a repeatable and accurately automated method of doing the CCC. The main advantage of the Zepto technique is that the CCC can be carried out irrespective of pupillary size, corneal clarity or lens density. Chang et al. concluded that the Zeptoadded no zonular stress as compared to CCC when performed in cadaver eyes.[13] Lastly, femtosecond lasers (FLACS)[14–16] facilitate creation of CCCs that are less variable, more repeatable, uniform in shape and have accurate desirable diameter.

However, there are a few inherent shortcomings in these markers that have been described. The technique described by Tassignon et al.[6] is not accurate because 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. Besides, it entails special production and procurement of the ring for making the rhexis-guide-marker. The Hassaballa marker[7] has not been attempted in human eyes because the introduction of the marker into the eye would require a 6mm incision and there is also the added factor of intracameral gentian violet toxicity. Similarly, the marker devised Rey de Faria MA et al.[8] is cumbersome to use in addition to the fact that it will be difficult to mark a perfect circle, inside the eye, on the anterior capsule using two separate halves. The disadvantage with the Morcher's ring, Verus ring[9] and the ORGC[10] by Lee et al. is primarily the difficulty that is associated with their insertion, placement, centration, use as a guide marker and subsequent removal at the hands of a first-year post-graduate ophthalmology-resident. Also, creation of a 2.2mm main port prior to creation of capsulorhexis would lead to anterior chamber collapse, especially when the resident is operating. The Wallace Capsulotomy diameter marker[11] may not be the best choice to use because the dye would wash off the cornea each time balanced salt solution (BSS) or OVD is used to prevent the cornea from drying, considering that the time taken by any first-year post-graduate ophthalmology-resident to complete the capsulorhexis would lead to the cornea drying up before completion of rhexis. Lastly, the Verion-Callisto IGS as well as the Zepto-Femto[13,16] assisted systems are not freely available in developing countries neither are they easily affordable enough nor do they have an easy leaning curve.

What we need right now is new single-use, easily portable devices designed especially for performing CCCs in a safe and reproducible way. The challenge would be to make these cost-effective and affordable so that they have a wider reach worldwide. It is this very niche that befits our technique. Firstly and most importantly, bandage contact lenses as well as trephines are easily procurable thus eliminating the issue of availability. Secondly, trephination of a bandage contact lens doesn't require any special learning curve and can easily be performed by a first-year post-graduate ophthalmology-resident. In fact this could even give them pre-emptive simulatory experience in trephining a donor cornea when they later learn keratoplasty. Thirdly, there are no cumbersome steps associated with entering the anterior chamber neither introduction of the marker nor placing it on the anterior capsule nor subsequent removal of the marker from the anterior chamber – steps that would involve a definitive steep learning curve for a first-year post-graduate ophthalmology-resident. Fourth, having a mark on the cornea that cannot be washed off would facilitate a more precise, more accurate, more controlled and more reproducible rhexis without the fear of the cornea drying up (because of the thin film of BSS between the cornea and the BCL).

There are a few limitations of our technique though. Firstly, there would be an expected amount of deficit in accuracy and precision as compared to the FLACS. However, our primary intention is providing a guide-marker to the first-year post-graduate ophthalmology-resident who is attempting to scale the learning curve of making a decent sized capsulorhexis. Second would be the difficulty in using this technique and the resultant alterations of the shape/centration of the CCC when using this method in eyes with irregular corneal curvatures. However, this is generally minimized, if not eliminated, because first-year post-graduate residents are mostly allotted clean uncomplicated cases for solo surgeries initially until they master the basic technical aspects and phacodynamics of surgery. Lastly, the time taken to create a CCC using our technique may take longer than the conventional manual approach. However, this increased time may be well-spent if it avoids intra-operative complications which often greatly increase surgical time ultimately. Our aim is that by the time the resident masters the art of a perfect-round-central-CCC, he/she reflexly has a visual gauge/guide-mark at 6mm and can easily perform the CCC without the use of our guide-marker, thus shortening his/her learning time and learning curve effectively.

5. Conclusion

CCC with contact-lens-guide-marker is expected to yield better results in carrying out the procedure more accurately being closer to the target in terms of size, circularity and centration as compared to contact-lens-unassisted conventional CCC. This would eventually facilitate better surgical outcomes and we recommend this to be applied as the standard protocol for first-year post-graduate ophthalmology-resident performing the surgery.

What was known

Phacoemulsification has now become the standard cataract surgery in which anterior capsulorhexis is the first and most crucial step. A perfect capsulorhexis is difficult to learn and even more difficult to master with a steep learning curve when performed free-hand especially by a first-year post-graduate ophthalmology-resident. There is paucity of simple, single-use, easily portable, cost-effective and affordable devices designed especially for performing CCCs in a safe and reproducible way.

What this paper adds

CCC with contact-lens-guide-marker is expected to yield better results in carrying out the procedure more accurately being closer to the target in terms of size, circularity and centration as compared to contact-lens-unassisted conventional CCC. This would eventually facilitate better surgical outcomes and we recommend this to be applied as the standard protocol for first-year post-graduate ophthalmology-resident performing the surgery.

Statement of justification

Capsulorhexis with contact-lens-guide-marker would yield better results in carrying out the procedure more accurately being closer to the target in terms of size, circularity and centration as compared to contact-lens-unassisted conventional CCC as well as shortening the learning time and learning curve for first-year post-graduate ophthalmology-resident performing the surgery.

Patient Consent

Consent to publish this case report has been obtained from the patient in writing.

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Declaration of competing interest

None of the authors have any conflicts of interest.

Acknowledgement

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajoc.2020.100889.

References

1. Joo CK, Shin JA, Kim JH. Capsular opening contraction after continuous curvilinear capsulorhexis and intraocular lens implantation. *J Cataract Refract Surg*. 1996;22(5): 585–590. Jun.
2. Jaffe NS. Preface. History of cataract surgery. In: Kwitko ML, Kelman CD, eds. *The History of Modern Cataract Surgery*. New York, NY: Kugler Publications; 1998:3.
3. Steinert RF, ed. *Cataract Surgery: Technique, Complications, & Management*. Philadelphia, PA: Saunders; 1995.
4. Kelman CD. History of phacoemulsification. In: Kwitko ML, Kelman CD, eds. *The History of Modern Cataract Surgery*. New York, NY: Kugler Publications; 1998:126.
5. Gimbel HV, Neuhann T. Continuous curvilinear capsulorhexis [letter]. *J Cataract Refract Surg*. 1991;17:110–111.
6. Tassignon M-J, Rozema JJ, Gobin L. Ring-shaped caliper for better anterior capsulorhexis sizing and centration. *J Cataract Refract Surg*. 2006;32:1253–1255.
7. Hassaballa MA, Osman AA. Delineating the extent of anterior capsulorhexis with gentian violet using capsulorhexis marker: a preliminary study of efficacy and toxicity in an animal model. *Clin Ophthalmol*. 2011;5:831–836.
8. Faria Marco Antônio Rey de, Ávila Marcos Pereira de, Pinheiro Francisco Irochima, et al. Effectiveness evaluation of a new surgical marker for anterior capsulorhexis. *Rev Bras Oftalmol*. 2017;76(1):11–16.
9. Kahook MY, Cionni RJ, Taravella MJ, et al. Continuous curvilinear capsulorhexis performed with the VERUS ophthalmic caliper. *J Refract Surg*. 2016;32(10): 654–658.
10. Lee JH, Lee YE, Joo CK. Clinical results of the open ring PMMA guider assisted capsulorrhexis in cataract surgery. *BMC Ophthalmol*. 2018;18(1):116. May 10.
11. Wallace RB. Capsulotomy diameter mark. *J Cataract Refract Surg*. 2003;29(10): 1866–1868.
12. Izak AM, Werner L, Pandey SK, Apple DJ, Izak GJ. Analysis of the capsule edge after Fugo plasma blade capsulotomy, continuous curvilinear capsulorhexis, and can-opener capsulotomy. *J Cataract Refract Surg*. 2004;30:2606–2611.
13. Chang DF, Mammalis N. Precision pulse capsulotomy preclinical safety and performance of a new capsulotomy technology. *Ophthalmology*. 2016;123:255–264.
14. Reddy KP, Kandulla J, Auffarth GU. Effectiveness and safety of femtosecond laser-assisted lens fragmentation and anterior capsulotomy versus the manual technique in cataract surgery. *J Cataract Refract Surg*. 2013;39(9):1297–1306.
15. Dilraj S, Grewal Schultz T, Basti S, Burkhard D. Femtosecond laserassisted cataract surgery-current status and future directions. *Surv Ophthalmol*. 2016;61:103–131.
16. Kovács I, Kránitz K, Sándor GL. The effect of femtosecond laser capsulotomy on the development of posterior capsule opacification. *J Refract Surg*. 2014;30:154–158.