Surgical Technique

Zepto-rhexis: A new surgical technique of capsulorhexis using precision nano-pulse technology in difficult cataract cases

Suresh K Pandey, Vidushi Sharma

Several techniques are used to make a capsulorhexis in white mature cataract cases as needle cystotome, Utrata capsulorhexis forceps, microincision capsulorhexis forceps, femtosecond Laser, etc. Zepto precision nano-pulse capsulotomy device (Mynosys Cellular Devices; Fremont, CA, USA) is Food and Drug Administration approved, a disposable capsulotomy device that uses low-energy pulses to create a precise central capsulorhexis, independent of pupil size, corneal clarity, or lens density. In this article, the authors report their experience of performing anterior circular curvilinear capsulorhexis with Zepto precision nano-pulse capsulotomy device in challenging cataract cases done at our center. The Zepto handpiece device was inserted through 2.8 mm clear corneal incision. Results of our study in 3 cataract cases (intumescent cataract, morgagnian cataract, and cataract with small pupil) revealed that the precision pulse capsulotomy technology mechanically and simultaneously cleaves all 360º of the apposed capsule of without cauterizing it, creating CCC of 5.2 mm size.

Key words: Capsulorhexis, Zepto precision pulse capsulotomy device, Zepto-rhexis

Videos Available on:
www.ijo.in

Access this article online

Website:
www.ijo.in

DOI:
10.4103/ijo.IJO_1006_17

Quick Response Code:

Creation of circular curvilinear capsulorhexis (CCC) is a very important step of modern phacoemulsification surgery.[1] Making a perfectly centered, adequate-sized (5–5.5 mm) capsulorhexis in white mature intumescent cataracts cases remains a challenge. Several techniques are used to make a CCC including needle cystotome, Utrata capsulorhexis forceps, microincision capsulorhexis forceps, femtosecond laser, and Zepto nano-pulse precision capsulotomy.[2]

A novel capsulotomy method and technology called precision pulse capsulotomy (PPC) has developed by Mynosys Cellular Devices; Fremont, Calif., USA.[2,3] The trade named "Zepto" received US Food and Drug Administration clearance in June 2017 and currently supplied in India by Care Group, Vadodara, India. In the metric scale, Zepto is one million times smaller than femto. Both the small size of the instrument and the several millisecond speed of capsulotomy creation inspired the name of the device. Precision nano-pulse capsulotomy device is a relatively inexpensive and disposable capsulotomy device that uses low-energy pulses to create a precise central capsulorhexis, independent of pupil size, corneal clarity, or lens density. Zepto capsulotomy device can be very helpful in white cataract cases, small pupils, subluxated cataract cases, and infantile cataracts, where a successful capsulorhexis is difficult, and an inadequate capsulorhexis may preclude premium intraocular lens (IOL) implantation.

Inserted through a clear corneal incision of 2.75 mm (now also with 2.2 mm), the device uses a gentle suction to create a uniform capsular contact. Capsulotomies are performed using a disposable handpiece with a soft collapsible tip and circular nitinol cutting element. Electrical nano-pulses are delivered to a nitinol (Nickel-Titanium) ring to create the capsulotomy instantaneously and simultaneously along all 360°, with no cautery or burning of tissue. Vaporization of water molecules trapped between the capsule and nitinol edge causes the stretched capsular membrane to split circumferentially all at once.[2,3]

A clear central window in the silicone shell surrounding the nitinol ring permits patients to fixate on the microscope light and allows the surgeon to center the capsulorhexis under direct visualization through the microscope. This device can create a capsulorhexis of 5.2 mm (or 4.8 mm) in size in cataract cases irrespective of lens density, pupil size, or corneal clarity. Our center was among the first centers to use the Zepto nano-pulse capsulotomy system (in India). The Zepto nano-pulse capsulotomy system has several advantages over a femtosecond laser: it is significantly cheaper (for developing countries), results in a stronger capsulotomy, provides fewer logistical challenges, and reduces overall surgical time.

In this article, the authors report their experience of performing anterior capsulorhexis with precision nano-pulse

SuVi Eye Institute and Lasik Laser Center, Kota, Rajasthan, India

Correspondence to: Dr. Suresh K Pandey, Suvi Eye Institute and Lasik Laser Center, C 13 Talwandi, Suvi Eye Hospital Road, Kota, Rajasthan, India. E-mail: suvieye@gmail.com

Manuscript received: 27.10.17; Revision accepted: 16.04.18

Cite this article as: Pandey SK, Sharma V. Zepto-rhexis: A new surgical technique of capsulorhexis using precision nano-pulse technology in difficult cataract cases. Indian J Ophthalmol 2018;66:1165-8.

capsulotomy device in a case of white intumescent cataract, hypermature cataract, and small pupil cataract cases done at our center using nano-pulse precision capsulotomy device [Fig. 1a and b].

Zepto-Rhexis: A New Surgical Technique in Difficult Cataract Cases – Report of 3 Cases

Case 1 – Cataract surgery with trifocal intraocular lens implantation in an intumescent cataract

A 36-year-old tax lawyer presented to us with painless decrease in vision (in his right eye) for last 6 months. On examination, his vision was hand movement (close to face) in the right eye and 6/6 (unaided) in the left eye. Intraocular pressure (IOP) was 16 mmHg in both eyes. He was diagnosed as white intumescent cataract in the right eye. He was keen to reduce dependency on glasses after cataract surgery. After detailed counseling, he selected the option of trifocal IOL (TRiDIFF Trifocal IOL-Care Group, India) during cataract surgery. Cataract surgery (in particular capsulorhexis) in this case of white intumescent cataract was challenging due to risk of runaway rhexis. Zepto precision nano-pulse capsulotomy device was used to create a successful capsulorhexis. After sideport incision, an air bubble was injected in the anterior chamber; this was followed by injection of trypan blue dye, followed by injection of chondroitin sulfate/sodium hyaluronate-based ophthalmic viscoelastic device (OVD) (Viscoat, Alcon Fort Worth, TX, USA). After staining the anterior capsule under air bubble, clear corneal incision was made. The Zepto handpiece was primed using balanced salt solution. The capsulotomy tip (silicone suction cup with nitinol ring) was retracted and inserted through clear corneal incision of 2.8 mm. The vacuum was achieved, followed by successful creation of circular capsulorhexis ("Zepto-rhexis") of 5.2 mm in size. The soft white cataract was aspirated using phaco aspiration. Irrigation and aspiration were done to remove the cortical tags. The capsular bag was filled with OVD (2% hydroxyl propyl methyl cellulose [HPMC]) and this was followed by implantation of TRiDIFF Trifocal Lens (Care Group, India) [Fig. 2a-c]. The OVD was removed and incision was sealed with balanced salt solution. Intracameral injection of preservative-free triamcinolone (0.05 ml or 2 mg to minimize postoperative inflammation) and moxifloxacin (Vigamox 0.1 CC, Alcon Lab, Fort Worth, TX, USA) was given. The patient achieved excellent vision postoperatively 6/6 and N6 (with excellent intermediate vision).

Case 2 – Cataract surgery with multifocal toric intraocular lens implantation in hypermature morgagnian cataract

A 40-year-old share broker presented to us with painless decrease in vision (in his right eye) for last 4 months. On examination, his vision was hand movement (close to face) in the right eye and 6/6 (unaided) in the left eye. IOP was 14 mmHg in right eye and 16 mmHg in the left eyes. On slit lamp examination, he had a white hypermature morgagnian cataract in the right eye. He was keen to have no (minimal) dependency on glasses after cataract surgery in the right eye. Detailed counseling was done and option of multifocal toric IOL was suggested to him (in view of cataract with corneal astigmatism of 2 Diopter). Cataract surgery (in particular capsulorhexis) in this case of white morgagnian cataract was challenging due to risk of runaway rhexis and release of the milky fluid. Zepto nano-pulse technology was used to create a successful capsulorhexis. The steps of staining the capsule and creation of capsulorhexis were same as in the first and a circular capsulorhexis of 5.2 mm in size was created. The dense nucleus of the morgagnian cataract was emulsified using phaco chop technique (Signature Ellips FX-Johnson and Johnson Vision Care, USA). Irrigation and aspiration were done to remove the cortical material. The capsular bag was filled with OVD (2% HPMC), and this was followed by implantation of multifocal toric IOL (Care Group, India). The OVD was removed and incision was sealed with balanced salt solution. Intracameral injection (0.1 ml) of preservative moxifloxacin was given. The patient achieved excellent vision postoperatively 6/6 (20/20) and N6 (unaided).

Case 3 – Cataract surgery with aspheric intraocular lens implantation in a small pupil

A 70-year-old retired businessman presented to us with painless decrease in vision (in his right eye) for last 8 months. On examination, his best-corrected visual acuity was 6/24 in the right eye and 6/18 in the left eye. IOP was 18 mmHg in the right eye and 14 mmHg in the left eye. He was diagnosed

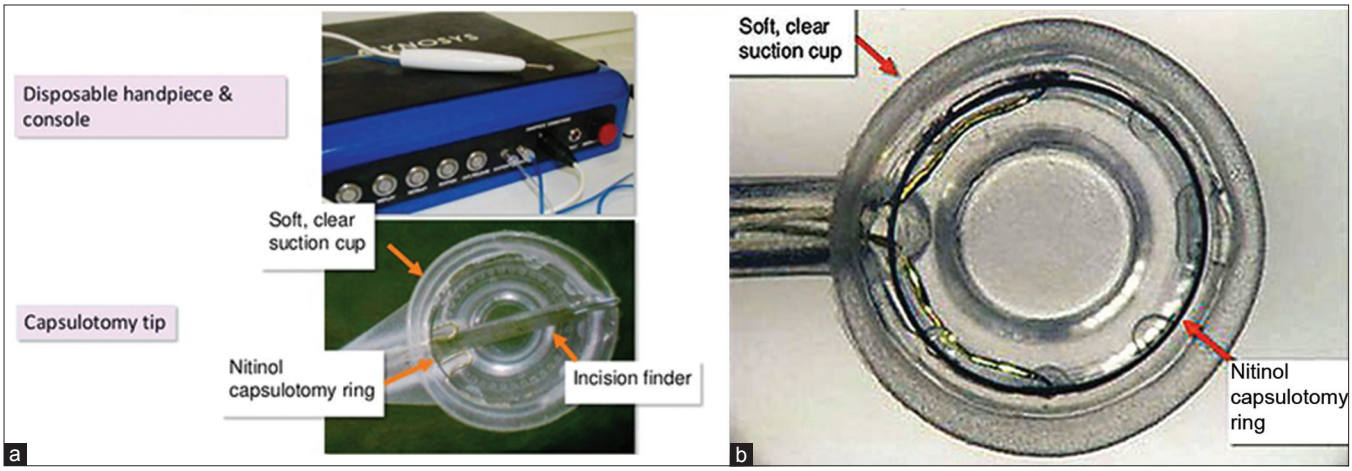

Figure 1: (a and b) Nano-pulse capsulotomy device

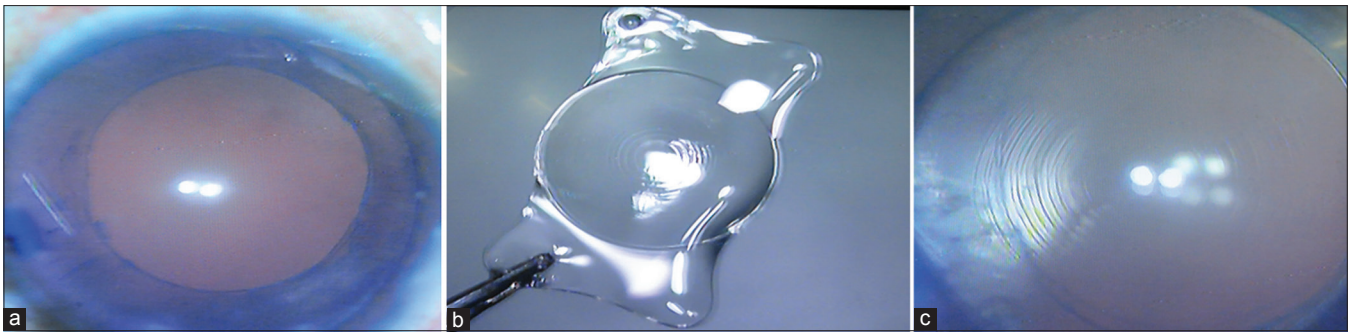

Figure 2: (a) Rhexis by nano-pulse capsulotomy device, (b) trifocal lens, and (c) well-centered trifocal intraocular lens in the capsular bag

to have age-related cataract in both eyes. He was also taking medication (tamsulosin hydrochloride) for benign prostatic hyperplasia. Detailed counseling was done and he selected the option of monofocal (aspherical) IOL during cataract surgery. Cataract surgery including capsulorhexis was difficult in this case of small pupil (floppy iris syndrome). Zepto nano-pulse technology was used to create a successful capsulorhexis in this case despite the small pupil. It is important to note that the flexible cutting device with the silicon shell can be placed under the pupillary edge to create an adequate-sized capsulorhexis. The Grade III nuclear cataract was emulsified using phaco chop technique; an aspheric monofocal IOL (Tecnis One-piece, Johnson and Johnson Vision Care, USA) was implanted in the bag. The OVD was removed and incision was sealed with balanced salt solution. Intracameral injection of preservative moxifloxacin (Vigamox 0.1 CC, Alcon Forth Worth, TX, USA) was done. The patient achieved excellent vision postoperatively 6/6 (P) and N6 (with addition of plus 2.5 Diopter).

Results of Zepto-Rhexis

It was possible to achieve capsulorhexis in intumescent cataract case using Zepto nano-pulse capsulotomy device in all 3 difficult cataract cases [Video 1]. The size of Zepto-rhexis was measured (stained capsular flap) and found to be 5.2 mm in size. There was no intraoperative complication related to Zepto nano-pulse capsulotomy device or IOL implantation.

Discussion

A precise, optimum-sized, and centrally placed capsulorhexis is crucial for in the bag implantation of premium IOLs.[1] An adequate overlap of the capsulorhexis edge all around the optic of the IOL also ensures the correct effective lens position of the IOL. Manual capsulorhexis is extremely good in most cases and has strong edges.[1] Femtosecond laser can help to achieve capsulorhexis in difficult cases, but it is associated with very high cost (machine and disposables). The size of the femtosecond laser machine and the need for imaging and docking create logistical workflow issues and limit its utility for eyes with small pupils.[4,5] At present, new devices are being designed to assist in the safe, fast, and repeatable creation of consistently strong and circular capsulotomies with less expense than that associated with femtosecond lasers.

Our study on three cataract cases revealed that Zepto nano-pulse technology is successful in achieving a well-centered and circular capsulorhexis. We are currently conducting a study to compare the endothelial cell loss with Zepto-rhexis in one eye and a manual capsulorhexis in the fellow eye. Other study with large number of cases is also in progress to evaluate CCC size, CCC centration, time taken to achieve CCC, and rhexis margin-IOL optic overlap using Zepto nano-pulse capsulotomy device.

Waltz *et al*.[6] evaluated PPC in simple and challenging cataract surgery cases and reported that Zepto technique had a short learning curve and was integrated seamlessly into the surgical routine. The authors concluded that the combination of suction with ultrafast capsulotomy provided capsulotomy roundness, sizing, safety, and edge quality that significantly facilitated difficult cataract cases. To the best of our knowledge, this is one of the first case reports from Indian subcontinent revealing intraoperative performance of Zepto nano-pulse capsulotomy device in white intumescent, hypermature, and small pupil cataract cases with premium IOL implantation.

CCC in white mature intumescent/morgagnian cataracts remains a challenge due to high intralenticular pressure, which can lead to a runaway rhexis (Argentinean flag sign).[7] Methods described to achieve a successful CCC in these cases which include the use of high molecular weight OVD (Healon 5, Johnson and Johnson Vision Care, USA), 2-step capsulorhexis, aspiration of cortical milk, etc. Zepto-rhexis is a very important and precise method to perform a successful CCC in these cases.

Zepto nano-pulse capsulotomy device had some limitation. One of the limitations of Zepto device is the need to insert it in the anterior chamber. There are concerns about possible endothelial cell loss in cases with shallow anterior chamber. Insertion of this device should be done very carefully in cases of nano-ophthalmos and phacomorphic glaucoma with very shallow anterior chamber. Preoperative injection of intravenous mannitol with or without pars plana vitreous tap may be helpful in these difficult cases to deepen the anterior chamber. We recommend the frequent use of chondroitin sulfate-based OVD (Viscoat, Alcon Fort Worth, USA) to coat the corneal endothelium to minimize endothelial cell lost during insertion or removal of the handpiece from the anterior chamber. Live rabbit studies done by researchers showed no issues with inflammation or endothelial cell loss.[3] In addition, thermocouple probe measurements confirmed that there is negligible temperature change within the anterior chamber associated with PPC.

There are other potential problems which can happen intraoperatively while using the Zepto PPC device. These include inability to open the device, suction loss, incomplete CCC, and difficulty in folding the device. However, we have not seen any of these complication(s).

This new technique helps to achieve a perfect-sized and well-centered CCC in difficult cataract cases, enabling the implantation of premium IOLs. The well-sized and central rhexis also ensures the correct effective lens position (ELP) in these cases, which is very crucial for premium IOLs.[8]

Conclusion

In summary, our experience of Zepto-rhexis in difficult cataract cases revealed that the PPC technology mechanically and simultaneously cleaves all 360° of the apposed capsule without cauterizing it in white cataract cases, seen commonly in developing countries like India. The obvious potential advantage of the Zepto PPC is its ability to reproducibly automate the capsulotomy step with a disposable instrument that is inserted in the conventional surgical sequence, and preclinical studies reported no significant endothelial cell loss.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Gimbel HV, Neuhann T. Development, advantages, and methods of the continuous circular capsulorhexis technique. J Cataract Refract Surg 1990;16:31-7.
2. Thompson VM, Berdahl JP, Solano JM, Chang DF. Comparison of manual, femtosecond laser, and precision pulse capsulotomy edge tear strength in paired human cadaver eyes. Ophthalmology 2016;123:265-74.
3. Chang DF, Mamalis N, Werner L. Precision pulse capsulotomy: Preclinical safety and performance of a new capsulotomy technology. Ophthalmology 2016;123:255-64.
4. Abell RG, Davies PE, Phelan D, Goemann K, McPherson ZE, Vote BJ, *et al.* Anterior capsulotomy integrity after femtosecond laser-assisted cataract surgery. Ophthalmology 2014;121:17-24.
5. Chang JS, Chen IN, Chan WM, Ng JC, Chan VK, Law AK, *et al.* Initial evaluation of a femtosecond laser system in cataract surgery. J Cataract Refract Surg 2014;40:29-36.
6. Waltz K, Thompson VM, Quesada G. Precision pulse capsulotomy: Initial clinical experience in simple and challenging cataract surgery cases. J Cataract Refract Surg 2017;43:606-14.
7. Yeoh R, Chee SP. Safer management of the white cataract. J Cataract Refract Surg 2013;39:306-7.
8. Pandey SK, Sharma V. Quest to create a perfect capsulorhexis. EC Ophthalmol 2018;9:355-7.