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*Original Article*

# Short-term outcomes of sulcus placed intraocular lens with optic capture in eyes with compromised capsular bag

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## ABSTRACT

**Objectives:** The aim of the study was to evaluate outcomes of sulcus placement of the intraocular lens (IOL) with optic capture in complicated case scenarios with compromised capsular bags.

**Materials and Methods:** Records of 31 patients (31 eyes) who had received implantation of IOL in the sulcus with optic capture as a primary or secondary procedure were retrospectively reviewed. The optic was captured in the capsulorhexis or remainder capsular opening while the haptics were placed in the sulcus. Primary outcome measures were the post-operative stability and centration of IOL, evaluated using slit-lamp examination and photography. Indications for optic capture and post-operative improvement in corrected distance visual acuity (CDVA) were also noted.

**Results:** Optic capture was well maintained and IOL well-centred with haptics secured in the sulcus in all patients at 1 month. Posterior capsular rupture during primary cataract surgery was the most common indication, followed by decentred IOL as a secondary procedure. CDVA improved from log MAR 0.9 ± 0.43 at baseline to log MAR 0.23 ± 0.15 at 1-month post-operative.

**Conclusion:** Optic capture is a safe and effective technique to achieve good IOL stability, centration, and visual acuity.

**Keywords:** Optic capture, Anterior and posterior CCC, Sulcus placement

## INTRODUCTION

The capsular bag remains the most favoured site for implantation of the intraocular lens (IOL). However, in the presence of insufficient capsular bag remnants during primary cataract surgery or secondary procedure, IOL can be implanted at substitute sites such as the anterior chamber or fixated to the iris or sclera.[1]

Sulcus implantation of IOL alone remains a safe and easy option when in the bag implantation is not possible, but there are chances of pupillary capture of the optic and IOL decentration with this method. Hence, as to impart stability to the IOL, in the event of posterior capsule rupture, Neuhann[2] captured the optic of the IOL in the anterior rhexis margin and placed the haptics in the ciliary sulcus. He coined the term 'rhexis-fixed lens' for this procedure. Gimbel and DeBroff[3] described six alternatives for capturing the optic depending on where the haptics and optic were positioned. Optic capture in the posterior CCC during primary IOL implantation in children and adults has been proven to be an effective measure in preventing posterior capsular opacification and maintaining a stable position of the IOL.[4,5] To achieve IOL stability when performing cataract and vitreoretinal surgery together, Lee *et al.*[6] successfully used the technique of capturing the optic in the anterior rhexis margin while positioning the haptics in the sulcus.

The aim of our study was to evaluate this technique in traumatic cataracts, decentred IOLs, and secondary IOL implantations with a compromised capsular bag as well as during primary cataract surgery. We wanted to assess outcomes of optic capture in achieving a centred and stable IOL with varying indications.

## MATERIALS AND METHODS

The study adhered to the tenets of the declaration of Helsinki and was approved by the Institutional Review Board. A retrospective review of 31 patients (31 eyes) who received sulcus implantation of IOL with posterior optic capture for different indications between August 2016 and July 2018 was done. Surgeries were performed by two experienced surgeons.

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All patients who received sulcus implantation of IOL with optic capture for any of the following conditions were included in the study: (1) Posterior capsular rupture (PCR) during routine cataract surgery, (2) surgical aphakia with pre-existing PCR but intact anterior continuous curvilinear capsulorhexis with or without vitreous in anterior chamber, (3) traumatic membranous cataract where in-the-bag IOL implantation was not possible, (4) hyper mature absorbed cataract with intact but fused capsular complex, (5) pseudophakia with decentred IOL implanted in the ciliary sulcus and (6) surgical aphakia with intact but fused capsular complex. A minimum follow-up of 1 month was required for inclusion in the study.

Complete ocular examination was done for all patients who included corrected distance visual acuity (CDVA), biometry, intraocular pressure (IOP), slit-lamp, and dilated fundus examination. CDVA was measured using the Snellen chart and converted to the logarithm of the minimum angle of resolution (log MAR) for statistical analysis. Biometry was performed with an optical biometer (IOL Master 700; Carl Zeiss Meditec, Germany/OA-2000; Tomey Corporation, Japan)) or Immersion A-scan (Biomedix; Optotechnik and Devices, India). IOP was measured with a non-contact tonometer (VISUPLAN-500; Carl Zeiss Meditec, Germany).

**Surgical technique**

All surgeries were done under peribulbar anaesthesia. Surgeries were performed using either a 5.5–6 mm superior sclero-corneal tunnel or 2.8 mm temporal clear corneal incision depending on the type of IOL used; rigid or foldable. In addition, two side ports were made 180° apart and the anterior chamber was inflated with 2% hydroxy propyl methyl cellulose. If the capsular opening was inadequate, it was enlarged using a vitrectomy cutter to make it approximately 4–5 mm. In cases of membranous or absorbed cataracts where the capsular bags were fused, the capsular opening was made using a vitrectomy cutter and limited anterior vitrectomy was done following which haptics of three-piece IOL were placed in the sulcus and optic captured in the residual capsular opening. Additional procedures of synechiolysis and lens matter removal had to be done in partially absorbed traumatic cataracts. A three-piece rigid IOL (B3602, Aurolens; Aurolab, India) or foldable three-piece IOL (AR40e, Sensar; Abbott Laboratories, the United States/MA60AC Alcon Laboratories; the United States) was placed in the ciliary sulcus and optic capture was done by pushing both sides of the optic one after the other, through the residual capsular opening or CCC depending on the case. The endpoint of successful optic capture was the oval configuration of round capsular opening [Figure 1]. Viscoelastic substance was aspirated and the anterior chamber was formed with a balanced salt solution. If necessary, a 10–0 nylon suture was used for wound closure.

Postoperatively, a combination of moxifloxacin 0.5% and prednisolone 1% eye drops was given to all patients, tapered over 4 weeks. In addition, homatropine 1% eye drops 3 times a day for a period of 2 weeks was also given. Patients were followed up on day 1, 1 week, and 1 month. At each follow-up visit, anterior segment examination was done by slit-lamp to look for signs of ocular inflammation, IOL position, and IOL centration. Heightened post-operative inflammation was considered if anterior chamber cells >+2 were seen. Decentration of IOL was defined when the edge of the optic was visible in the pupillary axis in an undilated pupil and the distance of the centre of IOL from the centre of the cornea was >2 mm on any side in a dilated pupil. Tilt was noted if any edge of the optic was out of captured anterior capsulorrhexis margin or either of the optic edges were not at the same plane [Figures 2 and 3].

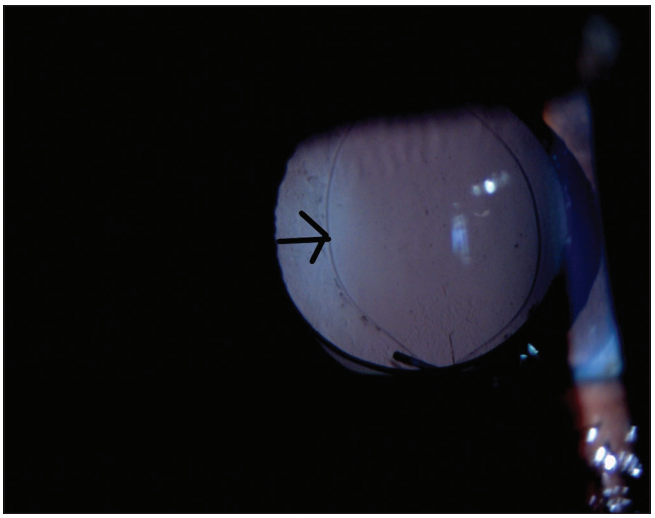

**Figure 1:** Black arrow indicating oval configuration of capsular bag after optic capture.

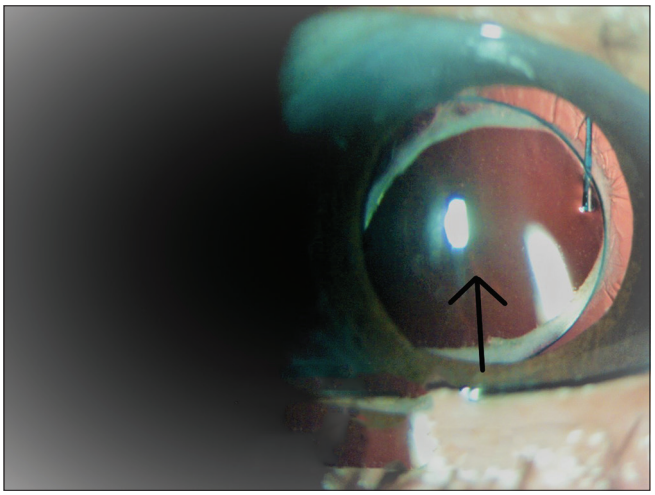

**Figure 2:** Black arrow depicting centration of intraocular lens as indicated by alignment of optic with visual axis.

IOP was measured either with a non-contact tonometer or Goldman applanation tonometer. Raised IOP was considered if measured IOP >22 mm of Hg.

### Statistical analysis

Statistical analyses were performed with SPSS 24.0 (SPSS Inc., Chicago, IL). Paired *t*-tests were used to compare the study groups. $P < 0.05$ was considered statistically significant.

## RESULTS

All 31 eyes had successful sulcus implantation of IOL with optic capture. Out of 31 patients included in the study, 22 (71%) were male. The mean age was 49.13 ± 18.67 years. [Table 1] shows the demographic data and clinical features including capsular status. Three-piece IOL was used in 26 eyes and in five eyes with decentred single-piece PMMA IOL, the same IOL was repositioned and captured.

[Table 2] shows the surgical outcomes. All eyes maintained optic capture with good IOL centration at the last visit. Mean pre-operative CDVA was 0.9 ± 0.43 which improved to 0.46 ± 0.28 on day 1. The mean CDVA further improved to log MAR 0.23 ± 0.15 ($P < 0.05$) at the 1-month review which was statistically significant. Five patients had lower visual gain than expected. The reason for the low visual outcome was the presence of corneal opacity impeding the visual axis in three patients and macular pathology and amblyopia in one patient each [Table 3]. Posterior synechiae and heightened anterior chamber inflammation were not reported in any patient. No statistically significant change in IOP was observed after surgery. Postoperative IOP was within the normal range in all but one patient who had a marginally raised IOP of 22 mm Hg requiring short-term anti-glaucoma therapy to become normal. Decentration or tilt of IOL was not noted in any of the patients at 1 month follow-up [Table 4].

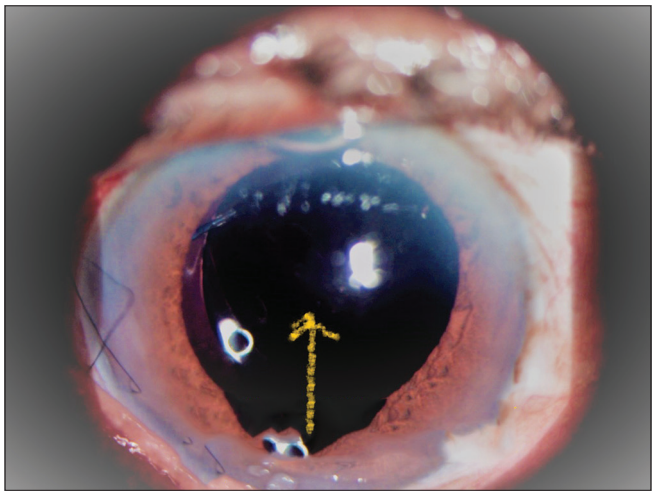

**Figure 3:** Well centered Intraocular lens after optic capture as highlighted by the yellow arrow.

## DISCUSSION

The present study evaluated the optic capture in eyes with IOL placed in the sulcus in a compromised capsular bag, during primary surgery or secondary intervention. It revealed that optic capture is a safe and effective technique in achieving satisfactory results of IOL implantation as regards centration and stability, as well as in achieving good visual outcomes.

Traumatic, hyper mature or posterior polar cataracts may have a compromised capsular bag in the pre-operative state thus increasing the probability of complications related to the capsular bag during surgery. Alternatively, PCR during routine cataract surgery may also jeopardise the capsular bag. Although sulcus implantation of IOL remains an appropriate alternative, the design of single-piece acrylic IOLs is not suitable for placement in the sulcus as this may result in long-term complications as reported in the literature.[7,8] Various studies[9,10] have reported decentration, tilt, and capture of IOL in the pupillary margin when IOLs have been placed in the ciliary sulcus.

Optic capture helps to maintain the separation of the anterior and posterior segments of the eye. This procedure obviates the need for any special instrumentation and is simple and less demanding when it comes to the learning curve.

In our study, we utilised two out of the six different methods of optic capture as reported by Gimbel and DeBroff: [3] (1) Haptics in the ciliary sulcus and optic captured in the anterior rhexis. (2) Optic captured in the remnant capsular opening while haptics was placed in the sulcus. Both these modalities resulted in good IOL centration and stability in all the patients. Our results are based on a study by Tian *et al*.[11] who observed that long-term stability of IOL is possible by sulcus placement of haptics and capture of the optic in the remaining capsular aperture.

The presence of a capsular opening that is slightly smaller than the IOL optic is the key to a successful optic capture which, in turn, ensures a centred and stable IOL.[3] In eyes with fused capsules precluding in-the-bag IOL placement (membranous traumatic cataracts, secondary IOL and decentred IOL), an opening of about 5 mm is either created or enlarged (if the capsule is already opened) by a vitrectomy cutter. In our experience, the capsules in secondary interventions were fibrotic and lacked stretchability, thus requiring more efforts for optic capture.

A three-piece IOL remains the first choice for optic capture, as the hinge at the haptic-optic junction allows the optic to be buttonholed posteriorly with ease. We used three-piece rigid or foldable IOL for optic capture in all but five patients. It was difficult to capture the optic in those five cases, where the same single-piece PMMA lens was repositioned and captured, but surgery was minimally invasive and completed with two 1 mm incisions.

**Table 1:** Demography and clinical characteristics of patients who underwent sulcus implantation with optic capture.

| S. No. | Age/Sex | Eye | Indication of POC | Capsular Status | Log MAR CDVA | |
|---|---|---|---|---|---|---|
| | | | | | Pre-Operative | One-month Post-Operative |
| 1. | 70/M | LE | Decentred PCIOL | ACCC intact | 0.48 | 0.48 |
| 2. | 46/M | LE | Decentred PCIOL | ACCC intact | 0.78 | 0.48 |
| 3. | 62/M | LE | Decentred PCIOL | ACCC intact | 1.3 | 0.0 |
| 4. | 22/M | LE | Decentred PCIOL | ACCC intact | 0.6 | 0.3 |
| 5. | 26/M | RE | Decentred PCIOL | ACCC intact | 0.78 | 0.18 |
| 6. | 60/M | RE | Surgical Aphakia | PCR with intact ACCC | 0.18 | 0.18 |
| 7. | 28/M | LE | Surgical Aphakia | PCR with intact ACCC | 1.0 | 0.18 |
| 8. | 65/M | LE | Senile absorbed cataract | Fused capsules | 1.78 | 0.3 |
| 9. | 33/M | LE | Decentred PCIOL | ACCC intact | 0.18 | 0.18 |
| 10. | 54/M | LE | PCR during cataract surgery | PCR with intact ACCC | 0.18 | 0.0 |
| 11 | 20/F | LE | Traumatic absorbed cataract | Fused Capsular Bag | 1.1 | 0.18 |
| 12 | 65/M | LE | Decentred PCIOL | ACCC intact | 0.30 | 0.00 |
| 13 | 18/M | RE | Traumatic Cataract | Pre-existing PCR | 0.78 | 0.48 |
| 14 | 60/F | LE | PCR during cataract surgery | PCR with intact ACCC | 1.78 | 0.18 |
| 15 | 80/M | RE | PCR during cataract surgery | PCR with intact ACCC | 0.78 | 0.3 |
| 16 | 66/M | LE | PCR during cataract surgery | PCR with intact ACCC | 1.0 | 0.18 |
| 17 | 57/F | RE | PCR during cataract surgery | PCR with intact ACCC | 1.3 | 0.0 |
| 18 | 60/F | LE | PCR during cataract surgery | PCR with intact ACCC | 1.0 | 0.18 |
| 19 | 65/M | RE | Senile absorbed cataract | Fused capsules | 0.78 | 0.48 |
| 20 | 56/M | LE | PCR during cataract surgery | PCR with intact ACCC | 1.0 | 0.3 |
| 21 | 58/F | RE | PCR during cataract surgery | PCR with intact ACCC | 1.0 | 0.18 |
| 22 | 66/M | RE | PCR during cataract surgery | PCR with intact ACCC | 1.3 | 0.18 |
| 23 | 65/F | LE | PCR during cataract surgery | PCR with intact ACCC | 1.0 | 0.3 |
| 24 | 60/M | LE | PCR during cataract surgery | PCR with intact ACCC | 0.78 | 0.18 |
| 25 | 24/F | LE | Traumatic cataract | Pre-existing PCR | 1.0 | 0.18 |
| 26 | 22/M | LE | PCR during cataract surgery | PCR with intact ACCC | 0.18 | 0.0 |
| 27 | 40/M | LE | Traumatic cataract | Pre-existing PCR | 0.78 | 0.48 |
| 28 | 54/F | LE | Decentred PCIOL | ACCC intact | 1.48 | 0.3 |
| 29 | 19/M | LE | Traumatic cataract | Extended ACCC | 1.1 | 0.3 |
| 30 | 36/F | LE | Surgical Aphakia | PCR with intact ACCC | 1.3 | 0.18 |
| 31 | 63/F | RE | PCR during Cataract Surgery | PCR with intact ACCC | 1.3 | 0.3 |

**Table 2:** Surgical outcomes of sulcus placed IOL with optic capture.

| Parameter | Mean±SD | *P*-value* |
|---|---|---|
| CDVA (log MAR) | | |
| Pre-operative | 0.9±0.43 | <0.05 |
| Post-operative (at 1 month) | 0.23±0.15 | |
| IOP | | |
| Pre-operative | 14.4±2.22 mm Hg | 0.133 |
| Post-operative | 14.58±2.4 mm Hg | |

*Paired t-test was used

**Table 3:** Number of patients with low visual gain (*n*=5).

| Number of Patients | Reason for low visual gain |
|---|---|
| 3 | Corneal opacity impeding the visual axis |
| 1 | Macular pathology |
| 1 | Amblyopia |

**Table 4:** Data of centration of IOL (*n*=31).

| IOL Position | First Post-operative Day | One-month Post-operative |
|---|---|---|
| Good Centration | 31 | 31 |
| Decentration/Tilt | 0 | 0 |

All patients in the present study had an IOP within the normal range, except one who had a marginally raised IOP of 22 mm Hg, which was controlled with topical antiglaucoma medication. This is in accordance with the study of Stifter *et al.*,[12] who concluded that eyes with primary posterior capsulorhexis (PPC) without posterior optic buttonholing (POBH), can have an increase in IOP in the early postoperative period as opposed to eyes with combined PPC and POBH. Possible explanations for this are, the inability of any residual viscoelastic substance trapped in the space behind the captured optic-capsule diaphragm to gain access to the anterior chamber and block the trabecular

meshwork; and second, avoidance of a pupillary block as the captured optic is positioned far from the pupil.

The majority of our patients except five achieved a visual acuity of log MAR 0.30 or better at the 1-month follow-up. Five patients had lower visual gain due to ocular comorbidities. In patients with the lower visual gain, one each had amblyopia and macular pathology whereas the remaining three had corneal opacity impeding the visual axis. IOL power adjustment for sulcus placement was not done as effective lens position was equivalent to in-the-bag implantation. This is consistent with the study by Millar *et al*.[13] who concluded that outcomes similar to in-the-bag implantation can be attained if the optic is captured in the anterior capsulorhexis.

## CONCLUSION

The majority of studies on optic capture are done in the paediatric population with the aim to prevent visual axis opacification. The studies were done in adult patients also demonstrated optic capture in routine cataract surgery with PCR. In addition to complicated surgery in senile cataracts, we also performed optic capture in traumatic cataracts, decentred IOLs, and secondary IOL implantations. It is, therefore, recommended that optic capture can be practiced in patients with compromised capsular bags wherein a capsular opening conducive for optic capture is present or can be created, as it helps in achieving better IOL centration and stability.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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