Efficacy and safety of primary tailored phacoemulsification combined with goniosynechialysis for refractory acute primary angle closure

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Research Article

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Abstract

**Purpose:** To assess the safety, efficacy, and long-term clinical outcomes of primary tailored phacoemulsification (phaco) combined with goniosynechialysis (GSL; phaco-GSL) in refractory acute primary angle closure (APAC) eyes with uncontrolled high intraocular pressure (IOP).

**Methods:** This retrospective case series comprised 51 eyes of 42 consecutive patients with refractory APAC and high IOP who were treated using primary tailored phaco-GSL at 3 hospitals in China, from 2014 to 2021. Preoperative and postoperative IOP, corrected distant visual acuity (CDVA), corneal endothelial cell density (CECD), intraoperative and postoperative complications were recorded. The safety, efficacy and subsequent long-term clinical outcomes were analyzed.

**Results:** The mean CDVA (LogMAR) was improved from 1.67±0.94 preoperatively to 0.23±0.26 postoperatively (P <0.001). Preoperative CECD was 2309.39±541.03 cells/mm² in 33 eyes and inaccessible in 18 eyes due to severe corneal edema; at the final follow-up, the mean CECD of all patients was 1823.50±533.40 cells/mm² (P <0.001). The mean IOP decreased from 48.51±6.25 mmHg preoperatively to 15.66±2.27 mmHg at the final follow-up (P <0.001). Among 51 eyes, additional tailored procedures performed were corneal indentation in 42 eyes, epithelial debridement in 9 eyes, giant epithelial bullae view in 4 eyes, pars-plana fluid aspiration in 3 eyes, and secondary intraocular lens implantation in 7 eyes. The IOP of all eyes was well controlled eventually and 47 eyes (92.16%) were successfully treated by phaco-GSL alone. No significant intraoperative or postoperative complications were observed.

**Conclusions:** Primary tailored phaco-GSL is a safe and effective surgical management strategy for patients with refractory APAC and high IOP.

Introduction

Asians, approximately 60% of world population, had the highest prevalence of primary angle-closure glaucoma (PACG) [1]. Acute primary angle closure (APAC) is the fundamental pathologic progress of PACG [2]. Traditional emergency management, including glaucoma medication and laser peripheral iridotomy (LPI), had been proven safe and effective in the treatment of the APAC eyes [3–5]. However, LPI was not always performed in all patients due to corneal edema or mid-dilated unreactive pupil, and a large number of APAC eyes are medically unresponsive [3]. Thus, the term "refractory" had been defined in previous studies as conditions that intraocular pressure (IOP) can't be managed with conventional approaches [6–10].

Despite increasing evidence-based studies demonstrating the efficacy of phacoemulsification (phaco) and goniosynechialysis (GSL; phaco-GSL) in patients with APAC [5, 7–12], this procedure remains a technical difficulty in patients with APAC and high IOP for many surgeons due to various challenges such as intractable corneal edema, shallow anterior chamber, floppy iris, or unstable lens [3]. Moreover, operating in the setting of high IOP and concomitant inflammation may be associated with higher risk of
intraoperative and postoperative complications such as posterior capsular rupture, suprachoroidal hemorrhage, and cornea decompensation [3, 13]. For these reasons, many doctors, especially those in primary hospitals and eye centers, were hesitant to perform surgery on patients with refractory APAC and high IOP. However, studies had elaborated that APAC patient presented with high IOP for more than 5 days had a significantly higher risk of poor vision prognosis and timely phakic surgery was essential to achieve a better visual outcome [14, 15].

When investigators evaluated the efficacy of phaco to manage refractory APAC, they described standard procedure but not the management of intraoperative challenges such as intractable corneal edema and extremely shallow anterior chamber [6–10]. In fact, however, the essential issues, such as how to address these specific challenges and increase accessibility and safety of phaco-GSL in the setting of refractive APAC and high IOP, were not well elaborated. Customized treatment approaches and identification of relevant clinical outcomes need to be collected and evaluated. This study was thus conducted to assess the safety, efficacy, and long-term clinical outcomes of primary tailored phaco-GSL in the treatment of refractory high IOP APAC patients who did not benefit from medical therapy and/or repeat anterior chamber paracentesis, and/or who were unsuitable for LPI.

**Methods**

**Participants**

This study has been evaluated by the institutional review board of Fujian Provincial Hospital and deemed not required ethics approval. The study was conducted in compliance with the guidelines of the Declaration of Helsinki by retrospectively reviewing the consecutive patients with refractory APAC and high IOP who were treated at three facilities between April 2014 and January 2021: Fujian Provincial (tertiary) Hospital, Fujian, China; Guangze County (primary) Hospital, Fujian, China; and Funing County (primary) Hospital, Fujian, China. Written informed consent was obtained from all patients prior to surgery.

Inclusion criteria for the current study included: (1) abrupt onset of symptomatic elevated IOP accorded with APAC; (2) uncontrolled IOP with maximal medical therapy and/or repeat anterior chamber paracentesis (IOP≥40 mmHg, even if temporarily reduced to <21 mmHg just after anterior chamber paracentesis); (3) conditions where LPI could not be performed due to severe corneal edema and mid-dilated unreactive pupil. Any history of previous intraocular surgery, intraocular inflammation, secondary angle closure due to uveitis, ocular trauma, choroidal effusion, suprachoroidal hemorrhage, or medication (e.g. topiramate), and ocular disease other than APAC and cataract, were excluded in this study.

**Preoperative Interventions**

All patients were initially treated with conventional management including systemic hyperosmotic agents (intravenous mannitol 250mL once daily), topical IOP-lowering agents (pilocarpine 1%, adrenergic agonists, carbonic anhydrase inhibitors, and β-blockers), and anterior chamber paracentesis. If IOP was
>40 despite maximal medical therapy, and LPI could not be performed, dexamethasone 5mg diluted in 100ml physiological saline was intravenously injected once daily. Topical corticosteroids were prescribed to control inflammation and topical antibiotic was used to prevent infection.

**Tailored Phaco-GSL**

Phaco-GSL surgery was scheduled 1-2 days after initial treatment unable to control IOP. All surgical procedures were performed under topical anesthesia and retrobulbar anesthesia by an experienced surgeon (WJ. W). 20% mannitol 250 mL was administered as an intravenous injection and paracentesis was performed in the ward prior to surgery.

Tailored procedures for severe corneal edema were as follows:

(1) Corneal indentation (CI). When eyes were presented with diffuse corneal epithelial edema and the visibility of operation field decreased, CI was performed to improve corneal clarity using a blunt tip cannula before undertaking continuous curvilinear capsulorhexis (CCC). CI could be repeated as necessary (Figure 1).

(2) Utilizing the surgical view though the giant epithelial bullae combined with CI (Figure 2). In the setting of corneal epithelial edema with bullae, good red reflex of the fundus was accomplished by adjusting the direction of the light incident angle, and standard phaco-GSL could be completed through the view of the giant epithelial bullae combined with repeated CI.

(3) Epithelial debridement. When diffuse corneal edema could not be improved using CI, or bullae were too small for surgical view, an epithelial debridement was performed. The surgeon used forceps to mechanically scrape away 7-mm central corneal epithelium and a bandage contact lens (BCL) was inserted immediately following the operation (Figure 3).

(4) Secondary intraocular lens (IOL) implantation. When corneal parameters were unavailable before surgery, a secondary in-the-bag IOL implantation was performed one week after phaco-GSL upon corneal improvement.

Tailored procedures for extremely shallow anterior chamber were as follows:

(1) A relatively small capsulorrhexis opening and in situ phaco technology. If CCC was challenged because of corneal edema and shallow anterior chamber, a relatively small capsulorrhexis opening was recommended. In situ phaco technology was effective with a smaller capsulorrhexis and it lessened the impairment of cornea and iris.

(2) Soft-shell technique. This technique created a smooth layer of dispersive ophthalmic viscoelastic device (OVD; Alcon Laboratories, Inc., Texas, USA) adjacent to the corneal endothelium to protect the endothelium.
(3) Pars-plana fluid aspiration. For eyes presenting with an extremely shallow anterior chamber where an aqueous misdirection was suspected, B-scan ultrasonography was performed preoperatively to exclude other causes such as suprachoroidal hemorrhage or choroidal effusion. If aqueous misdirection was suspected, pars-plana fluid aspiration was performed with a 27-gauge needle using 1-ml syringe (without plunger), inserted 3.5 mm behind the limbus to aspirate about 0.2 ml of liquefied vitreous (Figure 4).

Tailored phaco-GSL was accomplished in all cases via a 2.4-mm clear corneal incision and a foldable hydrophobic acrylic IOL (Tecnis ZCB00, Abbott Medical Optics, Santa Ana, CA, USA) was implanted immediately or secondarily. An OVD (sodium hyaluronate 15mg/ml; Shanghai Qisheng Biological Preparation Co. Ltd., Shanghai, China) was injected into near the angle for 360 degrees and further mechanical GSL was gently performed to dissect peripheral adhesion using iris repositor. After GSL, irrigation/aspiration was performed to meticulously and completely remove the OVD.

Postoperatively, all anti-glaucoma medication was discontinued. Postoperative therapy included topical antibiotics, corticosteroids, and nonsteroidal anti-inflammatory eye drops for 2, 4, and 8 weeks, respectively. Dexamethasone intravenous injection was continued for 1-3 days according to inflammation status. Eyes with an IOP >21 mmHg at 2 consecutive clinic visits resumed IOP-lowering drugs to lower IOP.

**Clinical evaluation**

Participants' demographic profiles, APAC symptoms, date of onset, and treatment history were collected. All patients underwent a comprehensive ophthalmic examination preoperatively and at the last follow-up visit, including Snellen CDVA (Log MAR), IOP, slit-lamp biomicroscopic examination, and corneal endothelial cell density (CECD, cells/mm$^2$). CECD was acquired by non-contact specular microscope and IOP was measured by non-contact tonometer (Topcon CT-1); when an intractable corneal edema or extremely high IOP impeded the measure, Schiotz tonometer was applied. IOP was defined as the mean of 3 measurements, among which the readings differed by <2 mmHg. Intraoperative and postoperative complications were recorded.

**Statistical analysis**

Demographics and patient characteristics were summarized as mean ± standard deviation (SD) (range: minimum-maximum) for continuous variables and number for categorical ones. Snellen visual acuity was converted to logarithm of the minimum angle of resolution (LogMAR) for statistical analysis. Counting fingers and hand movement vision were assessed for visual acuity as logMAR of 2 and 3, respectively.[16] pre-and postoperative changes in IOP, corrected distant visual acuity (CDVA), and CECD were represented as means ± SD. The paired t-test was used to detect the differences of quantitative variables when data obeyed normal distribution; otherwise, the Wilcoxon matched-pairs signed ranks sum test was used. Differences were considered statistically significant if the P-value was <0.05. All calculations were performed using IBM SPSS Statistics for Windows (Version 26.0., SPSS, Inc., Armonk, NY, USA).
Results

Baseline characteristics

From April 2014 to January 2021, an initial group of 239 patients who were diagnosed with APAC and underwent phaco-GSL surgery were screened. Of these, 197 were excluded from further evaluation: IOP was controlled by conventional therapy (medication and/or LPI; n=132); prolonged clinical course (greater than 2 months; n=31); history of previous intraocular surgery, including surgical iridotomy and trabeculectomy (n=13); rock hard cataract and manual small-incision extracapsular cataract surgery (n=5); and lost to follow-up (n=16). The 16 patients were lost to follow-up due to: death (n=2); incorrect telephone number (n=5); beyond study area (n=2); disability (n=3); and infirmity (n=4). Thus, 51 eyes of 42 patients (11 males and 31 females) were enrolled in the study, of which 39 eyes of 30 patients from Fujian Provincial Hospital, 9 eyes of 9 patients from Guangze County Hospital, and 3 eyes of 3 patients from Funing County Hospital.

Patient/eye characteristics were summarized in Table 1. The mean age was 67.06±8.55 years (range: 46-80 years) at the time of surgery. The mean follow-up was 29.69±15.78 months (range 6-73 months). All patients showed marked aqueous chamber cells preoperatively and hypopyon were formed in one eye (Figure 4). Preoperative ultrasound biomicroscopy (UBM) showed wide-range peripheral iridocorneal contact in all eyes.

Table 1. Characteristics
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Facility (patients/eyes)</th>
<th>Fujian Provincial Hospital</th>
<th>Guangze County Hospital</th>
<th>Funing County Hospital</th>
<th>Age (years)</th>
<th>67.06±8.55 (46-80)</th>
<th>Sex (male/female)</th>
<th>11/31</th>
<th>Sidedness (right/left)</th>
<th>24/27</th>
<th>Follow-up (months)</th>
<th>29.69±15.78 (6-73)</th>
<th>Interval between APAC onset and initial visit (days)</th>
<th>5.94±3.55 (2-14)</th>
<th>Interval between APAC onset and surgery (days)</th>
<th>7.37±3.93 (2-16)</th>
<th>IOP at initial visit (mmHg)</th>
<th>69.33±4.91 (40.17-81.65)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure (n)</td>
<td>Corneal indentation</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Utilizing the view though the giant epithelial bullae</td>
<td>4</td>
<td></td>
<td></td>
<td>Relatively small capsulorhexis and in situ phaco</td>
<td>51</td>
<td></td>
<td>51</td>
<td>Pars-plana fluid aspiration</td>
<td>3</td>
</tr>
</tbody>
</table>

APAC, acute primary angle closure; IOP, intraocular pressure.

**Complications**

Marked postoperative inflammation was observed in 32 eyes, of which 16 eyes presented with fibrinous exudates and 5 eyes had fibrinous membrane in pupils. Inflammation was eventually reduced by application of intravenous dexamethasone and topical corticosteroids. The residual fibrillate membrane of 2 eyes was removed during secondary IOL implantation (Figure 5). No other serious complication occurred after these procedures.

**Application of individually tailored procedures**
Among 51 eyes, additional tailored procedures performed were CI in 42 eyes, epithelial debridement in 9 eyes, giant epithelial bullae view in 4 eyes, pars-plana fluid aspiration in 3 eyes, and secondary IOL implantation in 7 eyes. Surgery was successfully performed in all patients, with improved visibility of operation field. All eyes adopted in situ phaco technology and soft-shell technique.

Clinical outcomes

Table 2 showed preoperative and postoperative patient/eye characteristics. The mean IOP was 69.33±4.91 mmHg at time of presentation and was 48.51±6.25 mmHg preoperatively. It decreased significantly to 14.37±2.89 mmHg 1 day postoperatively and was 15.66±2.27 mmHg at the final follow-up (P <0.001). Of 51 eyes, 47 eyes (92.16%) were successfully treated with resolution of acute episode and IOP less than 21 mmHg by phaco-GSL alone; additional 1 IOP-lowering medicine was required in 2 eyes and 3 medicines were required in 2 eyes, of which 1 eye had Ahmed glaucoma valve implantation due to drug resistance. The IOP of all eyes were successfully controlled eventually.

Visual acuity was improved in all eyes. The mean CDVA (LogMAR) was improved from 1.67±0.94 preoperatively to 0.23±0.26 at the final follow-up (P <0.001). Preoperative CECD was inaccessible in 18 eyes due to severe corneal edema. The mean CECD among 51 eyes was 1823.50±533.40 cells/mm\(^2\) at the final follow-up. The mean CECD loss was 20.71%.

Table 2. Pre- and postoperative characteristics

<table>
<thead>
<tr>
<th>Parameter (n=51)</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP (mmHg)</td>
<td>48.51±6.25</td>
<td>14.37±2.89†</td>
<td>P&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.66±2.27‡</td>
<td></td>
</tr>
<tr>
<td>CDVA (LogMAR)</td>
<td>1.67±0.94</td>
<td>0.23±0.26</td>
<td>P&lt;0.001*</td>
</tr>
<tr>
<td>CECD (cells/mm(^2))</td>
<td>2309.39±552.66†</td>
<td>1831.12±574.43§</td>
<td>P&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1808.25±490.72¶</td>
<td></td>
</tr>
</tbody>
</table>

CDVA, corrected distant visual acuity; CECD, corneal endothelial cell density; IOP, intraocular pressure.

*Statistical significance.

†The IOP at one day postoperatively

‡The IOP at final follow-up

§Available preoperative CECD of 33 eyes.

¶Inaccessible postoperative CECD of 18 eyes.
Discussion

Vision damage caused by refractory APAC is irreversible and may progress to loss of light perception [2]. To avoid these sequelae, especially in the case of conditions that conventional management can’t managed high IOP, timely lens extraction may play an indispensable role in IOP control and vision rescue [3, 5–9, 11]. However, the investigators only described standard phaco procedure but ignored the management of intraoperative challenges such as intractable corneal edema and extremely shallow anterior chamber to increase the accessibility and safety of phaco-GSL [6–10]. In this study, timely primary tailored phaco-GSL was conducted in refractory high IOP APAC patients and promising outcomes were achieved. The mean IOP was significantly reduced from 48.51 ± 6.25 mmHg preoperatively to 15.66 ± 2.27 mmHg at final follow-up and the mean LogMAR CDVA improved from 1.67 ± 0.94 to 0.23 ± 0.26.

Primarily, to operate on these patients with refractory APAC and high IOP, we suggested that retrobulbar anesthesia was essential, which could minimize the action of extraocular muscle while providing adequate sedation and a better patient experience.

Subsequently, severe corneal edema was the principal challenge which precludes a straightforward operation [3]; options to address the condition include CI, epithelial debridement, and utilizing the surgical view though the giant epithelial bullae. CI was considered as a rapid and portable method to reduce elevated IOP in the setting of some APAC patients since the sufficient pressure on the cornea would force aqueous peripherally into the drainage angle to reduce IOP and improve corneal clarity [17–20]. Using UBM, Matsunaga et al. observed that the anterior chamber angle in patients with relative pupil block or peripheral anterior synechiae was significantly widened after CI [19]. Rouzbeh et al. also found that indentation with a cotton bud in the central cornea of a globe model would open the angle and lead to iris movement [20]. In our study, CI was performed in 42 refractory APAC eyes with marked diffuse corneal epithelial edema to improve corneal visibility, of which no intraoperative complication or corneal damage was observed. In the case of corneal epithelial edema with bullous disorder, phaco-GSL could be performed with view from giant epithelial bullae. When CI was not an option or the bullae were too small for surgical view, corneal epithelial debridement was another attempt. The healing period for this procedure was previously reported to be 2–4 weeks [21]; therefore, in our study, BCL was applied immediately and postoperatively to accelerate corneal re-epithelization and to avoid postoperative grit and irritation [22]. We conducted epithelial debridement with BCL insertion in 9 eyes, all of which achieved corneal re-epithelization within 2 weeks. No patient reported postoperative pain and no hazy cornea was observed after healing. It is important to note that the surgeon needs to maintain good red reflex of the fundus to obtain the best surgical view regardless of the method used. Further, a secondary in-the-bag IOL implantation was recommended following resolution of corneal edema when corneal parameters were unavailable.

Furthermore, an extremely shallow anterior chamber was often showed in the patients with refractory high IOP APAC and was equally challenging for phaco surgery. A crowded anterior chamber accompanied the problem of safe access and increased the risk of complications such as endothelium cell loss, iris
prolapse, and malignant glaucoma [13]. In this study, in situ phaco technology and soft-shell technique, intended to diminish damage to corneal and uveal tissues [23], were adopted in all eyes and no significant cornea-related postoperative complications were observed. Additionally, in eyes with an extremely shallow anterior chamber that could not be deepened by OVD and misdirected aqueous in vitreous was suspended, a 27-gauge needle attached with 1-ml syringe (without plunger) was used to enable the outflow of vitreous fluid stable and controllable by siphon action. Usually, APAC happened in patients with more than 40 years old in whom physiological vitreous liquefaction has occurred and aspiration was considered to be safe [24]. Pars plana fluid or liquefied vitreous aspiration in phaco in the crowded eye has been reported in several cases series since 2002 [24–26]. These studies demonstrated that pars-plana fluid aspiration was a safe and effective procedure to remove a small volume of liquefied vitreous and to deepen the anterior chamber, thereby avoiding shallow anterior chamber-related complications [24–26].

These tailored procedures played a crucial role in handling intractable conditions to render phaco-GSL accessible and safe in patients with refractive APAC and high IOP. Notwithstanding, some surgeons remained concerned that primary phaco might lead to corneal decompensation in eyes with severe corneal edema or even bullous keratopathy. Our study showed that, although preoperative CECD was inaccessible in 18 eyes with severe corneal edema, none developed corneal decompensation after surgery, and the postoperative CECD was not significantly reduced. We assumed that severe corneal edema in refractory high IOP APAC eyes might resulted from temporary dysfunction of the active pumping mechanisms of the endothelium and were possibly reversible. Bigar et al. reported in their study that aqueous humour retention and accumulation of metabolic disturbances secondary to elevated IOP would result in hypoxia and cause temporary dysfunction of corneal endothelial cells [27]. This assumption was supported by Sperling’s experimental findings, in which they found that the mean corneal endothelial cell in APAC eyes worsen with time [28, 29]. Therefore, timely phaco-GSL was emphasized to save these dysfunctional corneal endothelial cells and to avoid substantial destruction after prolonged high IOP. Although phaco-GSL surgery itself might damage corneal endothelial cells, the mean CECD in this study was not significantly reduced, indicating that timely phaco-GSL in eyes with severe corneal edema or even bullous keratopathy was not contraindicated, but beneficial to eventual endothelial cell preservation [30].

Special attention should be paid to manage the inflammation of refractory high IOP APAC eyes. Significantly elevated inflammation-related cytokines were found in the aqueous of APAC eyes [31]. Moreover, scanning electron microscopy revealed that edematous irregular trabecular cells, numerous leukocytes, and activated macrophages were found in trabecular tissues of APAC eyes. Inflammation can also lead to breakdown of the blood-choroid barrier, choroid expansion, and vitreous body compression, resulting in forward displacement of the lens-iris diaphragm and thus shallower anterior chamber [32]. Therefore, it was suggested that active inflammation played an important role in persistent elevated IOP and might exacerbate TM edema, exudate, and choroid expansion, creating a vicious cycle; however, this cycle might be broken by timely primary phaco-GSL. Anti-inflammatory medications should also be prescribed topically and systemically, both preoperatively and postoperatively. In our study, all eyes
showed marked aqueous chamber cells preoperatively, with hypopyon seen in one eye. After surgery, inflammation with fibrinous exudate was observed in 21 eyes, which eventually improved by applying intravenous dexamethasone and topical corticosteroids.

There are some limitations of this study. First, since patients included those who presented with refractory high IOP APAC with intractable corneal edema or extremely shallow anterior chamber, we could not complete phaco absent a customized approach; thus, there was no control group. The other limitation was the loss of 16 patients to follow-up, which might have led to selection bias. However, among these 16, 9 patients (distance, 2; disability, 3; and infirmity, 4) who were excluded due to lack of postoperative data were interviewed by telephone and all reported satisfactory vision, plus patients with uncontrolled glaucoma were more likely to seek medical help. Therefore, we considered it would more likely to be underestimated rather than overestimated.

In conclusion, primary tailored phaco-GSL is safe and effective in the treatment of patients with refractory APAC and high IOP. Since this strategy requires no additional equipment, it is also an accessible and promising approach in underdeveloped and developing regions.

Declarations

Acknowledgements

None.

Authors’ contributions

Xinna Wu was responsible for designing the review protocol, writing the protocol, conducting the search, screening potentially eligible studies, extracting and analyzing data, interpreting results. Xiaobao Liu was responsible for designing the review protocol, screening potentially eligible studies, and analyzing data. Suzhen Xiao, Yajing Cai, Mengting Yu, Binqiang Xu and Yanling Wang contributed to conducting the search, data extraction, updating reference lists and provided feedback on the report. Wenjie Wu contributed to writing the report, extracting and analyzing data, interpreting results.

Funding

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Data availability

The data generated during or/and analyzed during the current study are available from the corresponding author.

Competing interests
The authors declare no conflict of interest.

**Ethics approval**

Ethics approval was obtained from Ethics Committee of Fujian Provincial Hospital.

**Consent to participate**

Patients provided written informed consent prior to undergoing any study procedure.

**Consent for publication**

Written informed consent included consent for publication of aggregated study results.

**References**


Figures
Figure 1

Corneal indentation (CI) in eyes with diffuse corneal edema.

(A) Eye presenting with diffuse corneal epithelial edema and decreased visibility of the surgical field. (B) Corneal clarity improvement after CI using a blunt tip cannula. (C-D) Repeat CI before intraocular lens implantation.
Figure 2

Slit-lamp photograph of eye with the giant epithelial bullae.
Figure 3

Corneal epithelial debridement in eye with refractory diffuse corneal edema.

(A) Eye presenting with refractory diffuse corneal edema. (B) Use of forceps to scrape away 7-mm central corneal epithelium when visibility of the surgical field cannot be improved by CI. (C) Bandage contact lens (BCL) inserted immediately postoperatively to protect the cornea; black arrow points to the edge of BCL. (D) Slit-lamp photograph showing greater transparency of the cornea 1 day postoperatively; black arrow points to the edge of BCL.
Figure 4

Pars-plana fluid aspiration in an eye with extremely shallow anterior chamber.

(A) The puncture point 3.5 mm behind the limbus (B) Pars-plana fluid aspiration using a 27-gauge needle attached to 1-ml syringe.
Figure 5

Inflammation in an eye with refractory acute primary angle closure and high intraocular lens (IOP).

(A) Marked preoperative inflammation with hypopyon and fibrinous exudate in an eye with IOP of 59.14 mmHg. (B) Secondary intraocular lens implantation was performed 1 week postoperatively after
removing fibrinous membrane formed after first surgery. (C) Clear cornea and anterior chamber at 3-month follow-up visit.