

# Endoscope-assisted goniosynechialysis combined with phacoemulsification and intraocular lens implantation to manage primary angle-closure glaucoma

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## Abstract

• **AIM:** To describe and evaluate a new ophthalmic endoscope surgical technique combined with phacoemulsification and intraocular lens (IOL) implantation to treat goniosynechialysis and manage primary angle-closure glaucoma (PACG).

• **METHODS:** Endoscope-assisted goniosynechialysis combined with phacoemulsification and IOL implantation was performed in 32 eyes of 29 patients with PACG. Regular follow-up was performed 1 week and 1 month, 3, and 6 months after surgery to assess complications, intraocular pressure (IOP), anterior chamber depth, visual acuity, and anterior chamber angle.

• **RESULTS:** Preoperative mean IOP was  $24.88 \pm 7.22$  mmHg with pharmacological treatment, and was  $13.70 \pm 4.02$ ,  $13.06 \pm 3.74$ ,  $14.29 \pm 4.70$ , and  $14.33 \pm 5.01$  mmHg 1 week, 1 month, 3 months, and 6 months after surgery, respectively. The postoperative decrease in IOP was significant ( $P < 0.05$ ). The rate for all eyes with IOP of 21 mmHg or less was 93.8% (30 eyes) at the final visit without ocular hypotensive agents. The average preoperative anterior chamber depth was  $1.60 \pm 0.64$  mm, and this value significantly increased to  $2.72 \pm 0.62$ ,  $2.76 \pm 0.70$ ,  $2.73 \pm 0.68$ , and  $2.74 \pm 0.71$  mm at 1 week, 1 month, 3 months, and 6 months, respectively. Visual acuity was improved in 28 eyes (87.5%) at 6 months postoperatively. The anterior chamber angle had increased in 25 eyes (78.1%) at the final visit; it was adhesive  $90^\circ$ – $180^\circ$  in 6 eyes,  $180^\circ$ – $270^\circ$  in only 1 eye. Two eyes exhibited minimal hyphema in the early postoperative period, but it could gradually be absorbed. Fibrinous reaction was observed in five eyes and spontaneously disappeared within 7 days. No shallow anterior chamber, iridodialysis, choroidal detachment, or malignant glaucoma was found in any eyes.

• **CONCLUSION:** Endoscope-assisted goniosynechialysis combined with phacoemulsification and IOL implantation to manage PACG has several advantages, including optimized visualization, greater accuracy, and improved safety. Our results suggest that it has certain curative effects and clinical application value.

• **KEYWORDS:** angle closure; glaucoma; goniosynechialysis; endoscope; phacoemulsification

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## INTRODUCTION

Glaucoma is the second cause of blindness in the world and one of the most common causes of irreversible blindness [1]. Over 20% of the world's glaucoma patients are in Asia; primary angle-closure glaucoma (PACG) is more prevalent in Asia compared to other countries and may result in greater morbidity [2]. Traditional exocular filtering surgery often fails due to complications. Many studies have reported the use of goniosynechialysis to treat angle-closure glaucoma [3,4]. Recent advances in endoscope technology have allowed the successful use of microendoscopes for intraocular surgery. Internal ocular structures can be clearly viewed, even during complicated procedures, such as pars plana vitrectomy [5], transscleral intraocular lens (IOL) fixation [6], cyclophotocoagulation [7], and selective trabecular surgery [8,9]. Here, we propose the use of endoscope-assisted goniosynechialysis combined with phacoemulsification and IOL implantation to treat PACG. This method allowed us to conveniently obtain a clearer and larger image of the angle structures, which might enhance surgical outcome and safety.

## SUBJECTS AND METHODS

**Subjects** This was a retrospective case series of non-consecutive PACG patients who were included if they had primary angle closure and failed to respond to medication. Those patients with secondary causes of angle closure, including trauma, posterior hemorrhage, or effusions, or those who underwent trabeculectomy or combined trabeculectomy and lens extraction were excluded.

Table 1 Pre- and postoperative IOP values and anterior chamber depths	$\bar{x} \pm s$				
	Preoperative	1 week	1 month	3 months	6 months
IOP (mmHg)	24.88±7.22	13.70±4.02 <sup>a</sup>	13.06±3.74 <sup>a</sup>	14.29±4.70 <sup>a</sup>	14.33±5.01 <sup>a</sup>
Anterior chamber depth (mm)	1.60±0.64	2.72±0.62 <sup>a</sup>	2.76±0.70 <sup>a</sup>	2.73±0.68 <sup>a</sup>	2.74±0.71 <sup>a</sup>

<sup>a</sup>*P*<0.05 vs preoperative value.

Ultimately, we included 32 eyes of 29 Chinese patients (12 males and 17 females, mean age of 59.72 ±9.66 years). Gonioscopy revealed that all eyes exhibited 180° -360° peripheral anterior synechiae. None had undergone antiglaucoma surgery, and all 32 eyes had been treated with medication. Informed consent for surgery was obtained in all cases, and the postoperative follow-up period was at least 6 months.

### Phacoemulsification and Endoscope-assisted Goniosynechialysis

**Microendoscope** Goniosynechialysis was performed with a fifth generation endoscope system (Polydiagnost, Pfaffenhoffen, Germany) equipped with a probe with a 0.55mm diameter, a 10-MP camera, a focal distance of 2-10mm, and a 70° field of view.

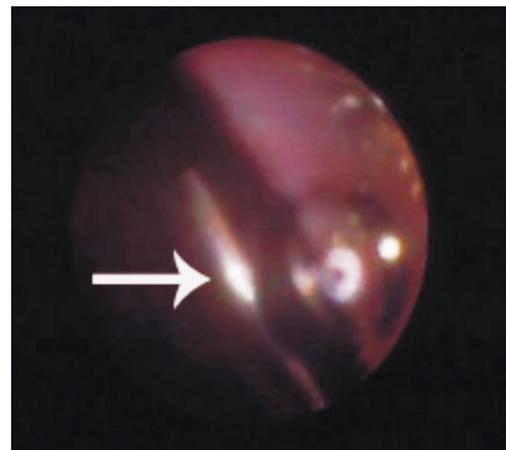
**Procedure** All patients underwent a standard phacoemulsification procedure using a superior corneal tunnel and foldable IOL implantation, and all lenses were placed in the bag. One small corneal paracentesis track was made at the temporal superior region in the left eye or nasal superior region in the right eye at 2-o'clock positions. The corneal tunnel and track were also used during goniosynechialysis (Figure 1). After lens implantation, the pupil was constricted with intracameral carbachol, and goniosynechialysis was performed with a viscoelastic material. For the endoscope-assisted goniosynechialysis procedure, a microendoscope was inserted into the anterior chamber through the corneal tunnel or corneal paracentesis track after the viscoelastic material was injected. The anterior chamber angle structures could be seen clearly on the monitor as the probe was pushed forward to the anterior chamber angle (Figure 2). Viscoelastic material was injected along the circumference of the peripheral anterior chamber to open the synechial angle through the corneal paracentesis track or corneal tunnel to assess where the angle was not yet open. This procedure was repeated along the entire circumference of the peripheral iris with 360 degree.

Intraocular pressure (IOP), anterior chamber depth, visual acuity, gonioscopy measurement and postoperative complications were recorded at each follow-up visit 1week, 1 month, 3 months, 6 months after the surgery.

**Statistical Analysis** Results are presented as mean ± standard deviation (SD). All data were analyzed with SPSS version 13.0 software for Windows (SPSS, Chicago, IL, USA). Differences for continuous variables were tested using paired Student's *t* tests. A *P* value of less than 0.05 was regarded as statistically significant.



**Figure 1** After phacoemulsification, the lens was placed in the bag. The superior corneal tunnel and corneal paracentesis track at 2 -o'clock positions were used during goniosynechialysis (one for the microendoscope probe and the other for the pinhead with viscoelastic material).



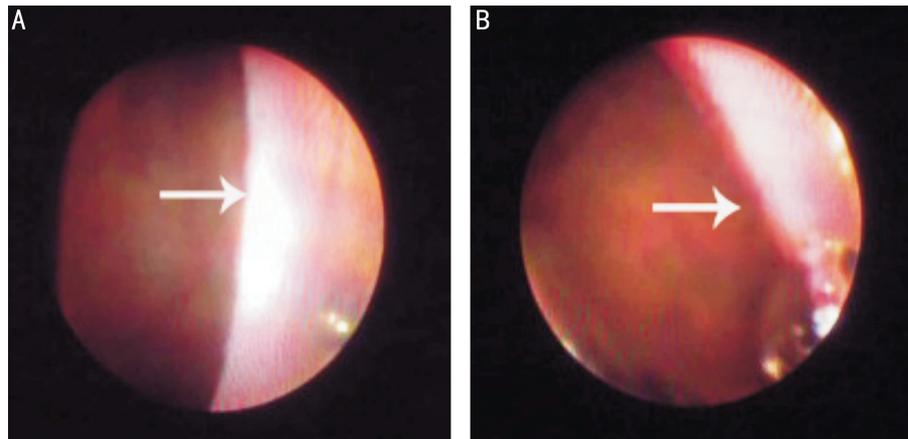
**Figure 2** The procedure in the anterior chamber could be viewed on the monitor. The arrowhead indicates the pinhead with viscoelastic material. A gas bubble is also visible in the anterior chamber.

## RESULTS

**IOP and Anterior Chamber Depth** The pre- and postoperative IOP values and anterior chamber depths are summarized in Table 1.

Overall, 93.8% (30/32) of all eyes had IOP values of 21mmHg or less at the final visit without the use of ocular hypotensive agents. Only two eyes exhibited IOPs over 21mmHg, which could be controlled with ocular hypotensive agents.

**Visual Acuity** Visual acuity did not decrease in any patient and had improved in 28 eyes (87.5%) at the 6-month postoperative follow-up.



**Figure 3 Endoscopic image of the anterior chamber angle** A: before goniosynechialysis. The arrowhead indicates anterior chamber angle adhesion; B: after goniosynechialysis. The arrowhead indicates the reopened anterior chamber angle. A gas bubble can still be seen in the anterior chamber.

**Anterior Chamber Angle** The anterior chamber angle had no change at 1 week and 6 months after the surgery.

Compared with preoperatively, the anterior chamber angle had increased in 25 eyes (78.1%) at the final visit (Figure 3). The anterior chamber angle was adhesive  $90^{\circ}$ - $180^{\circ}$  in six eyes and  $180^{\circ}$ - $270^{\circ}$  in one eye.

**Postoperative Complications** Two eyes exhibited a small amount of hyphema in the early postoperative period that was gradually absorbed. Fibrinous reaction was observed in five eyes and disappeared spontaneously within 7 days. No shallow anterior chamber, iridodialysis, choroidal detachment, or malignant glaucoma was observed in any eyes.

## DISCUSSION

Mechanisms of action in primary angle closure include pupillary block and plateau iris configuration. The primary goal of PACG treatment is to relieve the pupillary block that accelerates the cascade of events which results in anatomic angle closure. In the past, peripheral iridotomy or trabeculectomy was considered when IOP could not be controlled with medications. Peripheral iridotomy has about a 10% failure rate in IOP management when more than  $270^{\circ}$  of synechiae is present [10]. While trabeculectomy is commonly used to decrease IOP, it has a high failure rate due to postoperative surgical complications, such as predisposition to aqueous misdirection, a large inflammatory response with subsequent bleb failure, and the inherent long-term risks of bleb dysesthesia and blebitis. Surgery may cause the iris-lens diaphragm to move forward and block the angle and further narrow the anterior chamber. A study by Aung *et al* [11] showed that only 58% of patients exhibited IOP values below 21 mmHg following conventional therapy trabeculectomy. Moreover, the authors concluded that the high risks of failure and complications suggested that trabeculectomy may not be the best choice for medically unresponsive PACG.

Recently, lens extraction and posterior chamber IOL

implantation [12,13], goniosynechialysis [14], and phacoemulsification with goniosynechialysis [15] have been shown to successfully decrease IOP in PACG patients, and these procedures may have certain advantages over trabeculectomy. Goniosynechialysis is performed to release the mechanical block of the trabecular meshwork and is relatively safe because of the absence of a filtering bleb. Goniosynechialysis separates the iris from the angle wall, which allows the aqueous humour to have access to the trabecular meshwork. This surgery has fewer postoperative complications, and its effectiveness is enhanced when combined with cataract extraction. The increase in lens thickness with age and its relatively anterior position may play a role in angle-closure pathogenesis. Several studies reported that cataract surgery can also enhance the IOP-lowering effect of outflow reconstruction surgery [16]. Hayashi *et al* [17] and Lai *et al* [18] reported that cataract extraction surgery alone can reduce IOP to some extent in PACG patients.

Goniosynechialysis was previously carried out without visualization; it is difficult to achieve direct visualization of the chamber angle during goniosynechialysis using a conventional gonioscopic prism lens. Because the angle between the patient's and the surgeon's ocular axes must be at least  $30^{\circ}$ , it requires tilting of the operating microscope, eyeball rotation with bridle sutures to enhance observation of the superior and inferior chamber angles, and adjustment of the patient's head position to facilitate intraoperative visualization of the nasal and temporal angle areas. The plane of the trabecular meshwork is severely oblique to the surgeon's visual axis, and the focus points between the Schwalbe line and the iris recess differ under high magnification. These limitations reduce the quality of the chamber angle images and make it difficult to manipulate the procedures. Moreover, corneal opacity is also a major problem; corneal edema or opacification renders gonioscopic

observation of the chamber angle difficult or even impossible, and may preclude goniosynechialysis surgery. Recently, ophthalmic microendoscopes have been successfully used to illuminate and view internal ocular structures clearly in many intraocular surgeries. Here, we employed a microendoscopic technique to conveniently optimize visualization of the anterior chamber angle when performing goniosynechialysis procedures. This enhanced visualization and convenience improve accuracy and safety when performing goniosynechialysis.

The anterior chamber angle had opened in 25 eyes (78.1%) at the final follow-up visit. It was adhesive 90°-180° in six eyes and 180°-270° in only one eye. IOP was well controlled in a large majority of the eyes without pharmacological treatment. Only two eyes exhibited IOP over 21mmHg, but this was successfully controlled with ocular hypotensive agents. Of these, one eye's anterior chamber angle had over 180° adhesion, whereas the other's was adhesive less than 180°. We hypothesize that this was because the time of goniosynechia was too long, which damaged the effluent function of trabecular meshwork. With regard to clinical outcomes, this surgical technique was effective in managing PACG. Visual acuity improved in 27 eyes (84.4%) at 6 months postoperatively, and this favorable outcome was ascribed to simultaneous cataract surgery. Anterior chamber depths were also after the surgery, because the 1.0mm-thick intraocular lens implant was used to replace the 5.5mm-thick human lens. The obvious retroposition of the iris-lens diaphragm deepened the anterior chamber, which widened the drainage angle. The main complications were hyphema and fibrinous reaction, both of which disappeared spontaneously. We presume that the fibrinous reaction in the anterior chamber occurred as the result of breakdown of the blood-aqueous barrier.

There are several limitations to this study, most notably a small sample population and a relatively short follow-up time. However, our results demonstrate that intraocular microendoscopy provides a clear and highly magnified view of the chamber angle, irrespective of the media, and application of this method to goniosynechialysis can enhance the accuracy, safety, and convenience of the procedure.

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