

## Immediate Anterior Chamber Paracentesis with a 30-Gauge Needle for Acute Primary Angle Closure

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### Abstract

**Background:** Primary angle-closure glaucoma (PACG) is more common among Asians than among Caucasians. Acute primary angle closure (APAC) is a serious associated complication in PACG patients. When conventional treatment fails, Anterior Chamber Paracentesis (ACP) can be performed to decrease IOP. Although slit knives are commonly used for performing ACP, other techniques can also be used to perform this procedure.

**Objective:** To investigate the efficacy and safety of immediate anterior chamber paracentesis using a 30-gauge needle combined with conventional topical and systemic medications for the treatment of APAC.

**Materials and methods:** This prospective study was conducted in 15 consecutive primary angle-closure glaucoma patients that presented with and who were treated for acute primary angle closure (APAC) at the Department of Ophthalmology, Siriraj Hospital, (Bangkok, Thailand) during the January 2015 to December 2015 study period. Patients were included if they were older than 18 years of age, if this was their first known attack of APAC, and if they had an IOP  $\geq$  40 mmHg.

**Results:** Mean age of the 15 included participants (3 males, 12 females) was 61 years. Mean presenting IOP  $\pm$  SD was  $54.3 \pm 11.6$  mmHg. Twelve of 15 eyes had visual acuity worse than 6/18. Immediately after ACP, mean IOP  $\pm$  SD was  $7.5 \pm 5.1$  mmHg. None of the 15 included eyes were reactive to light prior to ACP. Mean pupil diameter was significantly reduced from baseline at 60 minutes after ACP ( $p=0.004$ ) and was significantly smaller than baseline at 24 h after ACP ( $p=0.03$ ). BCVA was improved to  $\geq$  6/18 in 11 and 12 eyes at 1 and 24 h after ACP, respectively. All patients had relief from symptoms immediately following ACP. No ACP-related complications were observed in any patient in this study.

**Conclusion:** Immediate APC with a 30-gauge needle is a safe and effective initial treatment for APAC. APC should be combined with conventional treatment with topical and/or systemic medications. APC yields rapid IOP reduction, dramatic relief of symptoms, and corneal clarity. APC may also improve response to further treatment, improve IOP control, and may reduce or eliminate the need for systemic medication.

**Keywords:** Anterior chamber paracentesis; 30-gauge needle; Acute primary angle closure; Glaucoma

### Background

The prevalence of Primary Angle-Closure Glaucoma (PACG) has been reported to be higher in Asian populations than in Caucasian populations [1-3]. Patients with APAC usually present with severe ocular symptoms, such as acute ocular pain, blurry vision, and redness. Prompt treatment is necessary to prevent irreversible damage to ocular structures, including anterior chamber angle, endothelial cells, and the optic nerve. The extent of damage depends on the duration of the acute episode and the level of IOP [4].

Conventional management includes combined topical and systemic medications, and Laser Peripheral Iridotomy (LPI) [5-7]. Given that the conventional treatment protocol occasionally fails to reduce IOP, additional interventions are sometimes required. High IOP results in cloudy cornea, which is an important factor that affects the success rate

of LPI. Systemic anti-glaucoma medication is associated with several known side effects, as well as some contraindications in specific conditions. Previous studies have reported Anterior Chamber Paracentesis (ACP) as a method for managing acute and otherwise unmanageable increases in IOP [8-10]. Lam, et al. reported the effectiveness of immediate ACP with a sterile 15 degree slit knife combined with systemic and topical anti-glaucoma medications [11]. They reported rapid control of IOP, improved corneal clarity, and relief from APAC-related symptoms. Although slit knives are commonly used for performing ACP, other techniques can also be used to perform this procedure.

The aim of this study was to investigate the efficacy and safety of immediate anterior chamber paracentesis using a 30-gauge needle combined with conventional topical and systemic medications for the treatment of APAC.

## Materials and Methods

This prospective study was conducted in 15 consecutive primary angle-closure glaucoma patients that presented with and who were treated for acute primary angle closure (APAC) at the Department of Ophthalmology, Siriraj Hospital, Bangkok, Thailand during the January 2015 to December 2015 study period. Siriraj Hospital is Thailand's largest university-based national tertiary referral center. Written informed consent was obtained from all patients prior to their inclusion in this study. The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (ClinicalTrials.gov.identifier: NCT01923454). This study complied with all of the principles set forth in the Declaration of Helsinki (1964) and all of its subsequent amendments.

Patients meeting all of the following criteria were included: 1) age >18 years; 2) first known attack of APAC; and, 3) IOP  $\geq$  21 mmHg. Patients meeting any one of the following criteria were excluded: 1) patients that declined ACP or that were uncooperative during the ACP procedure; 2) patients with APAC in the only remaining eye; 3) patients who received any glaucoma treatments prior to the study; 4) patients with secondary causes of acute angle closure; 5) patients with history of previous intraocular inflammation, ocular infection or ocular trauma ; 6) patients with APAC in an eye with history of previous intraocular surgery; and, 7) patients with known hypersensitivity to tetracaine hydrochloride or tobramycin.

At presentation, ocular examination included best-corrected visual acuity (BCVA), IOP measured by Goldman applanation tonometry, corneal edema grading, pupil size, and gonioscopy (by Shaffer grading system). Corneal edema grading was, as follows: grade 0=no corneal edema; grade 1=only mild corneal haze noted; grade 2=iris details blurred; grade 3=iris details only scantily visible; grade 4=iris details not visible.

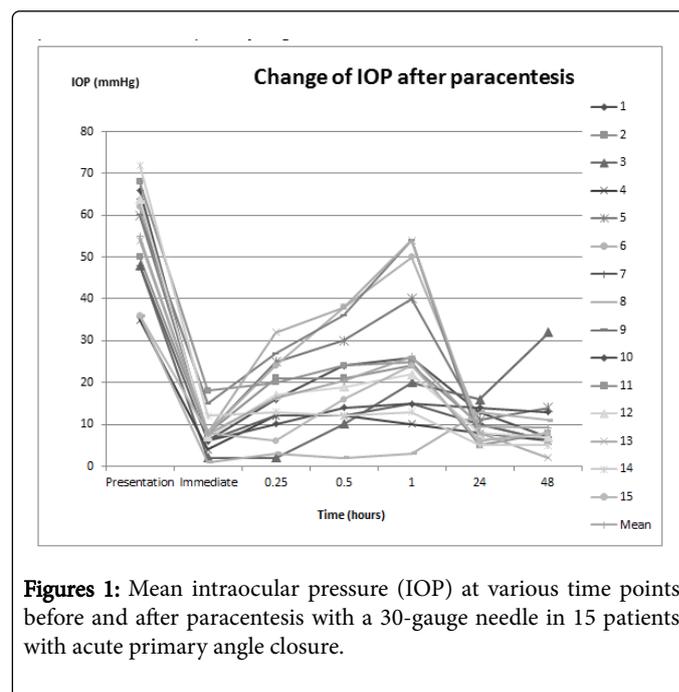
Before the ACP procedure, patients received instillation of tetracaine hydrochloride and tobramycin eye drop. A lid speculum was then placed in the involved eye. Anterior chamber paracentesis was performed by NK or SB using sterile technique at the slit-lamp biomicroscope. A sterile 30-gauge needle was connected to a 1 ml insulin syringe. Before the procedure, the plunger was removed from the 1 ml insulin syringe to allow for the free flow of aqueous humor. The 30-gauge needle was then passed through the temporal side of the mid-peripheral cornea to create a self-sealing side port. A sterile cotton swab was positioned at the nasal side of the limbus to stabilize the globe and to counter the force of the needle during the procedure. The 30-gauge needle tip was maintained within the anterior chamber until aqueous appeared in the needle hub or until there was no further aqueous flow. Tobramycin eye drop was administered immediately after ACP, and then every 6 h for 3 days. All patients received 0.5% timolol eye drop once and 2% pilocarpine eye drop every 15 minutes within 60 minutes after ACP, and underwent laser peripheral iridotomy (LPI) in both the affected and fellow eyes within 24 h after presentation. After LPI, all patients received 1% prednisolone eye drop every 6 h for 3 days and topical anti-glaucoma medications depending on the level of IOP. BCVA, IOP, corneal edema grading, pupil diameter, and symptoms were recorded immediately after ACP, and then at 15 minutes, 30 minutes, 1 h, 24 h, and 48 h.

## Statistical analysis

Data were analyzed using SPSS Statistics version 11.0 for window (SPSS, Inc., Chicago, IL, USA). Categorical data are presented as number and continuous data are presented as mean  $\pm$  standard deviation. Demographic data were summarized using descriptive statistics. Paired t-test was used to compare IOP, corneal edema grading and pupil diameter before and after APC treatment. A p-value of less than 0.05 was regarded as being statistically significant.

## Results

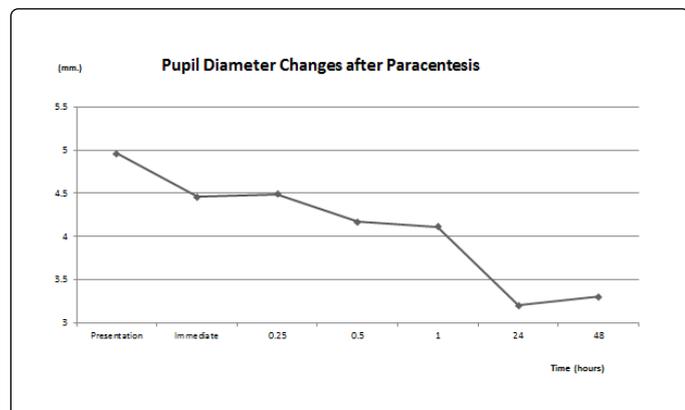
Mean age of the 15 included participants (3 males, 12 females) was 61 years. All patients were Thai. Demographic and clinical data are shown in Figure 1. Mean presenting IOP  $\pm$  SD was  $54.9 \pm 12.2$  mmHg. Twelve of 15 eyes had visual acuity worse than 6/18. Immediately after ACP, mean IOP  $\pm$  SD was  $7.8 \pm 4.5$  mmHg. Mean IOP then became 16.0, 20.5, 26.3, 9.5, and 9.3 mmHg at 15 minutes, 30 minutes, 1 h, 24 h, and 48 h after the procedure, respectively. The sequential change in IOP is shown in Figure 1. The corresponding mean pupil size is given in Figure 2. None of the 15 included eyes were pupillary reactive to light prior to ACP. Mean pupil diameter at presentation was  $5.0 \pm 0.9$  mm (range: 3.5-7). Mean pupil size was significantly reduced from baseline at 60 minutes ( $p=0.004$ ) and at 24 h ( $p<0.001$ ) after ACP.



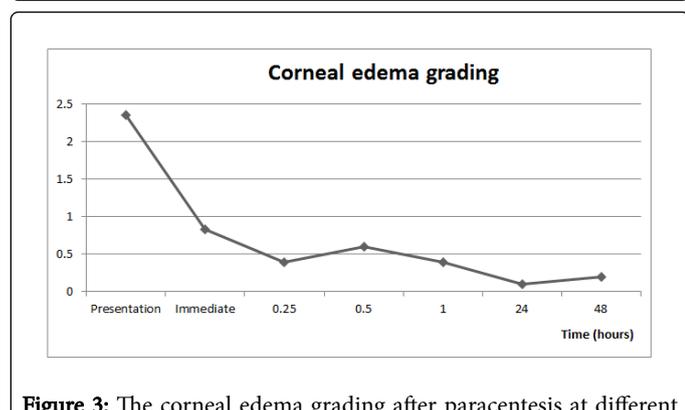
**Figures 1:** Mean intraocular pressure (IOP) at various time points before and after paracentesis with a 30-gauge needle in 15 patients with acute primary angle closure.

Ten eyes had at least 1 mm reduction in pupil diameter at 24 h after ACP combined with medical treatment and LPI. Mean corneal edema grading was significantly improved from 2.4 before ACP to 0.8 immediately after ACP ( $p=0.001$ ). Change in corneal edema grading is presented in Figure 3. BCVA was improved to equal to or better than 6/18 in 11 and 12 eyes at 1 and 24 hours after ACP, respectively. The change in BCVA between before and after ACP is shown in Figure 4. All patients had relief from symptoms immediately following ACP. No patients required intravenous mannitol to control IOP. IOP was successfully controlled with laser peripheral iridotomy and topical medications in 14 eyes. The remaining eye underwent filtration

surgery due to failure of maximal medication therapy. No ACP-related complications were observed in any patient in this study.



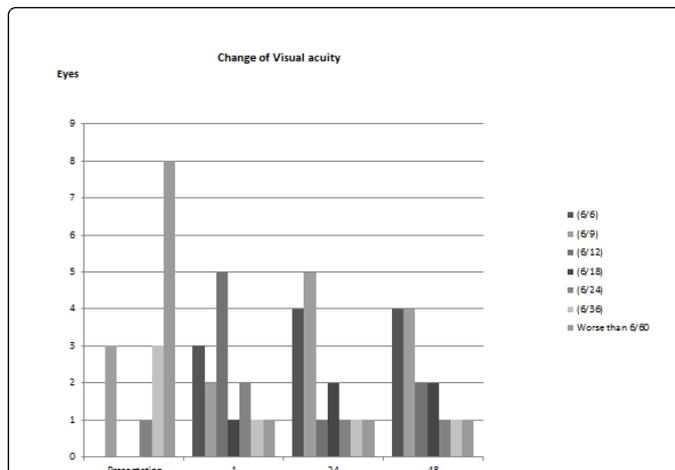
**Figure 2:** The changes of mean pupil diameter before and after treatment with immediate anterior chamber paracentesis.



**Figure 3:** The corneal edema grading after paracentesis at different time points. Grading for corneal edema: Grade 0-no corneal edema; Grade 1-only mild corneal haze noted; Grade 2-iris details blurred; Grade 3- iris details only scantily visible; Grade 4-iris details not visible.

## Discussion

The present study demonstrated the efficacy of anterior chamber paracentesis as initial treatment for acute primary angle closure. Similar to the results of previous studies, ACP resulted in the rapid reduction of IOP and effectively relieved the severity of APAC-related symptoms [11-14]. ACP alone in post-cataract surgery patients with spiking IOP could immediately reduce IOP, but the IOP increased again within approximately one hour [8]. Our study revealed the immediate effectiveness of ACP for reducing high IOP in eyes with APAC, but we also found a gradual increase in IOP within 1 hour in most eyes.



**Figure 4:** The visual acuity change after immediate anterior chamber paracentesis in eyes with acute primary angle closure.

There were only 6 eyes in which IOP was less than 21 mmHg at 1 h after APC. Even though there was recurrence of increased IOP after APC, IOP after APC was still less than the IOP level at presentation. This finding supports the assertion that ACP alone cannot correct the pathophysiologic mechanism of APAC. The effects of topical and systemic anti-glaucoma medications may start 30-60 minutes after APC, and will continue their effect after 60 minutes. In eyes with rapid rebound of IOP, we could perform laser iridotomy earlier when the cornea was still clear. Laser procedures, such as peripheral iridotomy and/or iridoplasty, can be performed easier with less energy and less manipulation than conventional treatment with medication alone.

The combined effects of early IOP reduction by APC, the continuing IOP lowering effect of medications, and laser PI resulted in IOP control within 24 h after presentation in most cases. This finding confirms that immediate ACP should be combined with conventional treatments [9]. The benefit of rapid IOP control is to limit the extent of potentially irreversible ocular tissue injuries. ACP may improve the patient's response to conventional treatment. After initial treatment, pupil size was reduced and IOP was reduced to under 20 mmHg in all 15 eyes. IOP was successfully controlled in a majority of eyes with topical medication and LPI, with only one eye requiring surgical intervention. That eye had duration of symptoms of 7 days and non-constricted pupil within 24 h after initial treatment, which was reported to be risk factors for requirement of surgical intervention in several studies [15-18]. No systemic hypoglycemic medications (e.g., mannitol or oral glycerine) were used in this study. This finding implied that immediate ACP reduced the use of systemic anti-glaucoma medication.

There were no ACP-related complications observed in this study. However, performing ACP in an eye with APAC was found to be more technically difficult than performing ACP in a post-phacoemulsification eye. Shallowness of the anterior chamber (especially less than 2 corneal thickness) and lack of patient cooperation were factors that increased the risk of potential complications, such as lens and iris damage. To minimize the risk of complications, we used a cotton swab to counteract the force of the 30-

gauge needle, and to stabilize the eye when passing the needle through the cornea.

We preferred to perform the ACP at the mid-peripheral cornea (instead of the most peripheral area), so that the tip of the needle was anterior to the anterior surface of the lens to avoid lens and iris damage. Preexisting anterior chamber shallowness may be aggravated by immediate ACP, leading to migration forward of the lens-iris diaphragm until it touches the cornea. We recommend performing paracentesis in eyes with an anterior chamber depth of more than 2 corneal thickness. Several previous reports describe different surgical techniques to perform ACP. Most studies used an ophthalmic surgical knife to enter directly into the anterior chamber, with a resulting release of aqueous humor through the wound [9,11,12].

We used a 30-gauge needle in this study due to its affordability and its wide availability. Lu et al. used a 27-gauge needle on a tuberculin syringe with its plunger in place to withdraw 0.3 ml of aqueous humor [13]. Their method required an assistant to pull back on the plunger of the syringe. As mentioned, we used a 30-gauge needle on a tuberculin syringe, but we removed the plunger to allow the aqueous humor to flow freely into the syringe. As such, there was no need for an assistant. The lumen of a 30-gauge needle is small enough to limit the flow of aqueous humor. When the flow of aqueous humor stopped, the mean IOP was self-limited to about 6 mmHg (range: 2-8). Moreover, the slow release of aqueous humor prevented abrupt shallowness of the anterior chamber and a resulting sudden change in IOP. Additional important advantages of controlling the flow of aqueous humor and controlling IOP include avoiding lens and iris damage, choroidal hemorrhage or effusion, and decompensation retinopathy [19-24]. None of these complications were observed in our series. With the use of a 30-gauge needle, we observed self-sealing of the wound and self-forming of the anterior chamber shortly after the ACP procedure was concluded.

The mentionable limitations of this study include the small number of participants and the lack of a comparison to conventional treatment alone. Nevertheless, the effectiveness of this procedure was demonstrated. A randomized controlled trial with a large sample size should be conducted to investigate longer-term treatment outcomes and the rate of associated complications.

## Conclusion

This study demonstrates that immediate APC with a 30-gauge needle is a safe and effective initial treatment for APAC. APC should be combined with conventional treatment with topical and/or systemic medications. APC yields rapid IOP reduction, dramatic relief of symptoms, and corneal clarity. APC may also improve response to further treatment, improve IOP control, and may reduce or eliminate the need for systemic medication.

## of Interest Declaration

The authors hereby declare no personal or professional conflicts of interest regarding any aspect of this study.

## Funding Disclosure

This was an unfunded study.

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