Title

Early phacoemulsification in patients with acute primary angle closure.

Journal

Iranian Journal of Ophthalmology, 27(3-4)

ISSN

2452-2325

Authors

Moghimi, Sasan

Hashemian, Hesam

Chen, Rebecca

et al.

Publication Date

2015

DOI

10.1016/j.joco.2015.12.001

Peer reviewed

HOSTED BY
ELSEVIER
CrossMark
Available online at www.sciencedirect.com
ScienceDirect
Journal of Current Ophthalmology 27 (2015) 70–75
http://www.journals.elsevier.com/journal-of-current-ophthalmology

Early phacoemulsification in patients with acute primary angle closure

Sasan Moghimi [a,*], Hesam Hashemian [a], Rebecca Chen [b,c], Mohammadkarim Johari [a], Massood Mohammadi [a], Shan C. Lin [b]

[a] *Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran*
[b] *Department of Ophthalmology, University of California, San Francisco, CA, USA*
[c] *Case Western Reserve University School of Medicine, Cleveland, OH, USA*

Received 3 November 2015; revised 28 November 2015; accepted 9 December 2015
Available online 12 January 2016

Abstract

***Purpose*:** To compare long term efficacy of phacoemulsification in the early management of acute primary angle closure (APAC) after aborting an acute attack and performing laser peripheral iridotomy (LPI).
***Methods*:** In this nonrandomized comparative prospective study, we included 35 subjects presenting with APAC who had responded to medical treatment and LPI with intraocular pressure (IOP) less than 25 mmHg. Twenty patients with visually significant cataract with visual acuity of <20/30 were assigned to the "*Phaco/LPI*" group and underwent phacoemulsification within 6 weeks of the attack. Fifteen subjects with clear lens were assigned to the "*LPI Only*" group and were followed clinically. The primary measured outcome was the prevalence of IOP rise after 1 month (treatment failure), defined as 1) if a patient developed IOP rise resulting in IOP >21 mmHg with or without medication, or 2) if a patient required any medication to have IOP ≤21 mmHg after 1 month. Patients were followed for at least one year.
***Result*:** IOP, number of medications, gonioscopy grading, and amount of synechiae were not significantly different at baseline between the two groups. Acute attack did not recur in any patient. There was more significant failure in the *LPI Only* group compared with the *Phaco/LPI* group (40% vs. 5%; $p = 0.02$). There was a significant difference in final IOP between the two study groups (13.90 ± 2.17 vs. 17.8 ± 4.16 in the *Phaco/LPI* and *LPI Only* groups, respectively; $p = 0.001$). Patients in the *Phaco-LPI* group needed less medication than the other group at final follow-up. No serious complications have arisen from the immediate LPI or phacoemulsification.
***Conclusion*:** Phacoemulsification is a safe procedure for preventing IOP rise after aborting acute primary angle closure if performed within a few weeks of the attack.

Keywords: Phacoemulsification; Acute primary angle closure; Gonioscopy; Synechiae; Intraocular pressure

Introduction

Primary angle closure glaucoma (PACG) is estimated to affect 15 million people worldwide and is responsible for 50% of glaucoma blindness.[1] Early detection of PACG can prevent morbidity in a large proportion of affected patients, and early treatment can minimize any damage to the anterior chamber angle and optic nerve.[2]

Acute primary angle closure (APAC) is a subgroup of angle closure disease characterized by sudden intraocular pressure (IOP) rise and its consequences, such as headache, corneal edema, reduced vision, seeing halos around lights, mid-dilated and sluggish pupil, eye pain, and redness.[3–6] An ophthalmologic emergency, its treatment has two arms: IOP reduction and relief of angle closure. Although laser peripheral iridotomy (LPI) can relieve angle closure, open the angle, and prevent

The authors did not receive any financial support from any public or private sources. The authors have no financial or proprietary interest in a product, method, or material described herein.
* Corresponding author. Farabi Eye Research Center, Tehran University of Medical Sciences, Quazvin Sq., Tehran, Iran. Tel./fax: +98 2155416134.
E-mail address: sasanimii@yahoo.com (S. Moghimi).
Peer review under responsibility of the Iranian Society of Ophthalmology.

http://dx.doi.org/10.1016/j.joco.2015.12.001

acute attacks in most cases, many reports indicate that it does not completely prevent chronic angle changes, and up to 60% of LPI-treated patients eventually develop chronic IOP rise.[1,3,4,6,7]

A lens-induced mechanism in the development of APAC has been suggested. A thick crystalline lens might lead to angle closure through reduction of anterior chamber depth and narrowing of the angle.[8–10]

Previous studies have reported IOP control and angle opening after phacoemulsification in PACG.[11–15] Phacoemulsification has been shown to be effective in refractory cases of acute angle closure as well as in eyes with controlled attacks.[6,16–18] Roberts et al successfully treated APAC patients who did not respond to LPI with phacoemulsification.[18] In a randomized clinical trial, Lam et al[6] showed that early phacoemulsification might be more effective than LPI in preventing IOP rise in APAC eyes after aborting an attack. They recommended that it would be optimal to have the surgery done after the eye has become quiet to reduce intraoperative complications and postoperative inflammation.

The aim of this nonrandomized interventional cohort study in an Iranian population is to evaluate the effect of early phacoemulsification on long-term IOP control after successful control of attack with medications and LPI.

Methods

In this nonrandomized interventional prospective study, the study population consisted of 40 eyes of 40 Iranian patients with APAC attacks. Patients were seen at the glaucoma clinic and emergency ward of Farabi Eye Hospital between April 2008 and March 2012.

Written informed consent was obtained from all participants. Approval was obtained from the institutional review board Farabi Eye Hospital. The study was carried out in accordance with the tenets of the Declaration of Helsinki.

Acute primary angle closure was defined as: (1) having at least 2 of these symptoms: ocular or periocular pain, nausea and/or vomiting, and intermittent vision blurring; (2) intraocular pressure of more than 25 mmHg measured by Goldmann applanation tonometry in conjunction with at least three of these signs: corneal epithelial edema, conjunctival injection, non-reactive mid-dilated pupil, and shallow anterior chamber; and (3) presence of an occluded angle in the affected eye that is proven by gonioscopy. Occludable angle closure was defined if the posterior trabecular meshwork could not be visualized in at least 3 quadrants.

The inclusion criteria were: (1) uncontrolled IOP (IOP >25 mmHg) caused by APAC; (2) age of at least 18 years; and (3) ability to give informed consent and cooperate for the YAG laser procedure. Exclusion criteria were: (1) previous history of intraocular surgery or trauma; (2) glaucomatous optic neuropathy in the affected eye; (3) any other treatments for the acute attack received before enrollment in the study; (4) corneal opacity in the peripheral iris preventing laser access; and (5) other ocular disorders that may affect function or structure of the angle.

The acute primary angle closure attack was managed with a fixed protocol initially. First we administered intravenous mannitol followed by oral acetazolamide (1 g/day), topical timolol two times per day (BID), pilocarpine four times per day (QID), and corticosteroid (QID). The IOP was measured at 2 h and at 1 day after the starting attack. The attack was considered broken when IOP was less than 25 mmHg (with or without medication) and when signs and symptoms of acute IOP rise had subsided. Once IOP was reduced medically, all subjects were assessed for eligibility for the study.

LPI

All the patients underwent LPI. After administering 2% pilocarpine, laser treatment was started with a single 5-mJ pulse (Nd:YAG laser), and the power was increased until a 200 μm patent opening was achieved. Patency of the LPI was determined by visualization of fluid flush coming out of the opening and by LPI size using the 0.2 scale of the slit lamp beam scale. A single glaucoma specialist (S.M.) performed all laser procedures. All the patients received topical timolol (BID) and corticosteroid (QID) for 1 week postoperatively. Additional glaucoma medications were added to the regimen if necessary.

Grouping

After excluding the patients whose IOP was higher than 25 mmHg within 10 days after medical (more than 3 medications) and laser treatment, the patients classified into “visually significant cataract” group (*Phaco/LPI Group*) and “clear lens” group (*LPI Only Group*). Significant cataract was defined as best corrected visual acuity (BCVA) <20/30 that can be attributed to lens opacity. Patients in the *Phaco/LPI Group* underwent early cataract surgery within 6 weeks of the attack. Cataract extraction was performed under topical anesthesia using a standardized temporal clear corneal approach. We placed intraocular lenses in the capsular bag in all eyes. All operations were performed by a one surgeon (S.M.). Patients in the *LPI Only Group* were followed in the clinic.

Follow-up and examination

Slit-lamp examination of the anterior segment, Goldmann applanation tonometry, and gonioscopy (with and without indentation) using a Zeiss-style 4-mirror goniolens (Model G-4; Volk Optical, Mentor, Ohio, USA) were conducted before LPI and 10 days after LPI. The Shaffer grading system was used to evaluate the angle on gonioscopy. Peripheral anterior synechiae (PAS) were defined as abnormal adhesions of the iris to the angle to the level of the trabecular meshwork which are at least 15° in width, and could not be broken with indentation gonioscopy. The extent of PAS was noted in degrees. The data from the exam performed at 10 days after LPI was considered as baseline for comparison with exam findings at the final follow-up.

After treatment, both groups were followed at day 1; day 7; day 10; months 1, 3, 6, 9, and 12; and every 6 months thereafter.

We scheduled additional visits when indicated. Both groups had a minimum follow-up period of 1 year. At each visit, BCVA, IOP, gonioscopy, peripheral anterior synechiae (PAS) extent, and medical therapy were recorded. Visual field was evaluated by 24-2 Swedish Interactive Thresholding Algorithm (SITA-Standard) strategy (Humphrey Field Analyzer, HFA II; Carl Zeiss Meditec, Inc., Dublin, CA) every 6 months. The visual field was defined as reliable when fixation loss was <33% and the false positive and false negative error rates were <20%. Intraocular pressure greater than 21 mmHg with or without medication after 1 month was defined as treatment failure in this study.

During follow-up, if IOP was more than 21 mmHg or if the patient experienced repeated visual field progression, topical glaucoma medications were initiated to maintain IOP≤21 mmHg. We administered glaucoma medications in the following order: beta-blockers, prostaglandin analogs, carbonic anhydrase inhibitors, and adrenergic agonists. The primary measured outcome was the prevalence of IOP rise (treatment failure), which was defined as 1) if a patient developed IOP rise resulting in IOP>21 mmHg with or without medication, or 2) if a patient required any medication to have IOP ≤21 mmHg after 1 month.

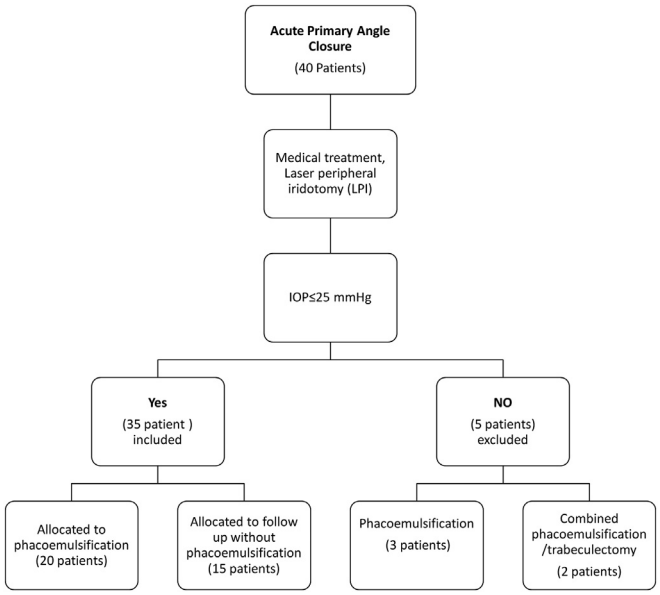

Fig. 1. Patient flow from presentation to study exit. IOP = intraocular pressure (mmHg).

Statistics

Statistical analyses were performed using SPSS for Windows (version 18.0, SPSS, Inc., Chicago, IL). The mean and SD were calculated for the continuous variables. Categorical variables were expressed as individual counts and proportions. Univariate analyses were performed using the Mann–Whitney U test for continuous variables and chi-square test for categorical data. Preoperative and postoperative data were compared using the Wilcoxon signed-rank test. A p-value less than 0.05 was considered to be statistically significant.

Results

Forty eyes of 40 patients with acute PACG were recruited into the study. Before LPI, gonioscopy revealed completely closed angles or poorly visible angles due to corneal edema. After LPI, the mean Shaffer gonioscopy grading increased from 0.25 ± 0.29 to 1.35 ± 0.78 ($p = 0.001$). Of the 40 eyes, 5 were excluded because IOP control could not be achieved with medications after LPI. Three of these 5 patients underwent phacoemulsification, and the other 2 underwent combined phacotrabeculectomy procedure. Among the final study sample, 20 patients had significant cataract and underwent phacoemulsification (*Phaco/LPI* group). The remaining 15 patients underwent no procedures after LPI (*LPI Only* group) (Fig. 1). LPI was performed in all patients within 5 days of presentation. All the subjects in the *Phaco/LPI* group underwent phacoemulsification within 6 weeks of the attack with a mean of 23.6 ± 9.2 (range: 12 to 42) days. No serious complications have arisen from the immediate LPI or phacoemulsification.

The demographic and clinical characteristics of the two treatment groups are presented in Table 1. The majority of patients were female (15 out of 20 in the *Phaco/LPI* group and 12 out of 15 in the *LPI Only* group), with the mean age of 61.1 ± 6.9 (range: 52 to 74) years in the *Phaco/LPI* group

Table 1
Patient demographics and ocular characteristics for the subjects recruited into the study and assigned in the Phaco-LPI group and the LPI only group.

	Phaco-LPI group	LPI only group	p values
No	20	15	
Age (years)	61.1 ± 6.9	60.0 ± 8.9	0.61
Gender (female/male)	15/5	12/3	0.73
Onset of self-reported symptom to consultation (days)	4.6 ± 4.7	5.1 ± 4.8	0.56
Maximum IOP at presentation (mmHg)	54.0 ± 9.4	57.1 ± 10.2	0.45
Time between abortion of attack and LPI (days)	2.1 ± 1.6	1.7 ± 1.5	0.16
Time between abortion of attack and phacoemulsification (days)	23.6 ± 9.2	–	–
Mean shaffer gonioscopy grading before LPI	0.27 ± 0.29	0.21 ± 0.30	0.52
Vertical cup-to-disc ratio	0.32 ± 0.17	0.35 ± 0.19	0.61
Mean deviation (dB) 1 months after procedure	−6.01 ± 3.35	−5.88 ± 3.55	0.56
Axial length (mm)	21.56 ± 0.67	21.52 ± 0.67	0.97

IOP: intraocular pressure; LPI: laser peripheral iridotomy.

Table 2
Change in best corrected visual acuity, intraocular pressure, number of medication, and drainage angle parameters, between baseline (10 days after laser peripheral iridotomy [LPI]) and final follow-up in the Phaco/LPI and LPI only groups.

	Baseline	Final follow-up	*p* values
IOP (mmHg)			
Phaco-LPI group	16.65 ± 2.75	13.90 ± 2.17	0.006
LPI only group	16.47 ± 2.71	17.80 ± 4.16	0.90
p values	0.88	0.001	
Number of medication			
Phaco-LPI group	1.10 ± 0.91	0.50 ± 2.20	0.001
LPI only group	0.93 ± 0.79	0.80 ± 1.08	0.71
p values	0.65	0.06	
Shaffer gonioscopy grading			
Phaco-LPI group	1.34 ± 0.47	2.88 ± 0.40	<0.001
LPI only group	1.36 ± 0.89	1.14 ± 0.92	0.69
p values	0.82	0.04	
PAS (Degrees)			
Phaco-LPI group	149.0 ± 128.1	66.0 ± 128.2	0.007
LPI only group	154.0 ± 118.0	178.1 ± 124.5	0.04
p values	0.87	0.02	
BCVA (logMAR)			
Phaco-LPI group	0.51 ± 0.28	0.29 ± 0.24	0.003
LPI only group	0.09 ± 0.08	0.10 ± 0.08	0.15
p values	<0.001	<0.01	

BCVA: best-corrected visual acuity; IOP: intraocular pressure; LPI: laser peripheral iridotomy; LogMAR: logarithm of minimum angle of resolution; PAS: peripheral anterior synechiae.

and 60.0 ± 8.9 (range: 51 to 74) year in the *LPI Only* group. There were no statistically significant differences in gender, age, presenting IOP, time to presentation (from onset of self-reported symptoms to clinical consultation), axial length, gonioscopy grading, and vertical cup-to-disc ratio between the two groups before LPI. Intraocular pressure, number of medications, gonioscopy grading, and the amount of PAS were not significantly different at baseline (Table 2). However, the *LPI Only* group had better visual acuity than the *Phaco/LPI* group. All the patients were followed for at least 1 year. The mean follow-up period was 18.5 ± 5.2 months (range of 12–24 months).

Acute attack did not recur in any patient, as all iridotomies remained patent. There was significantly more treatment failure in the *LPI Only* group (6/15 [40%]) compared with the *Phaco/LPI* group (1/20[5%]; $p = 0.02$). All subjects classified as treatment failure in this study were medically controlled at the final follow-up and did not need any further intervention. None of the patients with controlled IOP received the medication for VF progression. Four out of 6 failures in the *LPI Only* group and the only failure in *Phaco/LPI* group developed within the first 6 months of follow up.

Fig. 2 demonstrates the pattern of IOP change in both groups during the follow-up period. There was a significant difference in the final IOP between the two groups (13.90 ± 2.17 vs. 17.8 ± 4.16 in *Phaco/LPI* and *LPI Only* groups, respectively; $p = 0.001$). Intraocular pressure was significantly lower in the *Phaco/LPI* group throughout the follow up period (all $p < 0.005$; Fig. 2). The *Phaco/LPI* group patients needed fewer medications than did the other group at the final follow-up for IOP control.

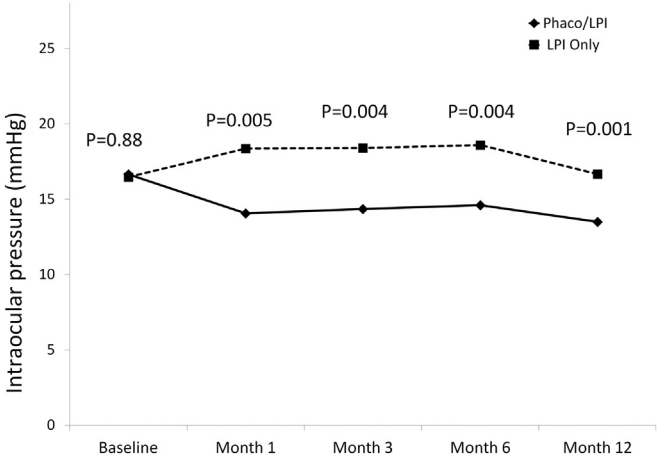

Fig. 2. Line chart of intraocular pressure (IOP) over time. Although the IOP was not significantly different between the two groups, Phaco/Laser peripheral iridotomy *(Phaco/LPI)* group has significantly lower IOP than *LPI Only group* during follow-up.

The BCVA (logMAR) improved in the *Phaco/LPI* group from 0.51 ± 0.28 at baseline to 0.29 ± 0.24 at the final follow-up ($p = 0.003$). There was no significant change in BCVA in the *LPI Only* group.

The change of average angle width and amount of PAS in each group is shown in Table 2. There was a significant increase in angle width from baseline to final follow up in the *Phaco/LPI* group ($p < 0.001$). Mean average gonioscopy did not change in the *LPI Only* group throughout the follow-up period. Baseline mean extent of synechial angle closure was not different between two groups ($p = 0.87$), although more PAS was observed in *LPI Only* group after 1 year ($p = 0.02$). The amount of PAS decreased from 149.0 ± 128.1 to 66.0 ± 128.2° after phacoemulsification ($p = 0.003$). However, the *LPI Only* group experienced an increase in amount of PAS during the follow-up period, from 149.0 ± 128.1° after LPI to 178.1 ± 124.5° at the final visit; $p = 0.04$).

Discussion

This study demonstrates the positive effects of early cataract surgery on opening the angle, reducing PAS, and controlling the IOP in patients with APAC. Forty percent of patients who did not undergo phacoemulsification experienced IOP rise subsequently.

LPI is an effective measure to prevent acute attack in APAC eye and is believed to prevent progression to PACG in these eyes. However, previous studies have produced conflicting results and different rates of conversion to PACG. In Caucasians, 65–76% of patients had long term medication-free controlled IOP with surgical or laser iridectomy alone.[1,4,6,17,19,20] With use of glaucoma medications, this rate increases to 84–99%.[3]

A report on Asian eyes revealed a 58.2% conversion rate to PACG after LPI alone in APAC. Most of conversions to PACG occurred during the first 6 months after LPI.[3] Consistent with these studies, our data revealed that after LPI 40% of patients

need medications for adequate IOP control, and 60% of patients developed IOP rise in the first 6 months, indicating the importance and need for strict follow-up after LPI, especially during this early period. There is no study in the Iranian population that reports the natural history of APAC after LPI. However, in a recent study on PACG patients who underwent LPI, Alipanahi et al showed that only 15% of eyes maintained IOP control without medication after 21 months.[21]

The literature describing the effect of LPI on amount of PAS is controversial. Although one study demonstrated a decrease in PAS extent after LPI,[17] several studies showed that LPI has little effect on reversing established synechiae and but may prevent progressive synechial closure after the procedure.[22] In our *LPI Only* group, the PAS extent increased approximately 20° during the follow-up period. Overestimation of PAS extent before LPI in eyes with very shallow anterior chambers in those studies and ethnic differences in study populations may account for the discrepancy.

We observed that amount of PAS was significantly reduced in the *Phaco/LPI* group. Mechanical deepening of the anterior chamber during phacoemulsification may relieve PAS to some extent.[13] Some investigators reported beneficial effects of a procedure called goniosynechiolysis, combined with phacoemulsification, to widen the anterior chamber angle, especially in cases of APAC with recently formed PAS.[16,23–25] This observation has also been reported by Tham et al in Hong Kong[26] and Husain et al[17] in Singapore in APAC eyes.

Desirable effects of lens extraction in glaucomatous and nonglaucomatous eyes have been addressed recently in several studies.[11–15,27] Lens extraction has been shown to have greater effect on IOP in eyes with refractory APAC and in eyes with broken attacks.[6,16–18] Moghimi et al found that eyes with APAC have thicker lens and greater lens vault than do other subtypes of angle closure.[28–30] Phacoemulsification, by removing the thick lens, can effectively open the drainage angle and deepen the anterior chamber, as measured by ultrasound biomicroscopy.[31]

One randomized control study[6] evaluated 62 eyes that received either early phacoemulsification or LPI after breaking the APAC attack by medication. After 18 months, prevalence of IOP rise was significantly higher in the LPI group (46.7% versus 3.2%). The study proved phacoemulsification is superior to LPI for long-term IOP control after an APAC attack. Consistent with these studies, the rate of conversion to PAC was much lower in our *Phaco/LPI* group (5%) than in the *LPI Only* group (40%). We also observed lower IOP in the *Phaco/LPI* group at all postoperative visits, and the *Phaco/LPI* group required fewer medications at the final visit. This beneficial effect of phacoemulsification has been shown in another randomized control trial,[6] although there is some evidence in contrary.[17]

Phacoemulsification after acute attack of angle closure is a challenging task. The surgery is technically challenging due to a shallow anterior chamber, poor mydriasis, posterior synechiae adherent to the lens, weakness of the zonular fibers, and perhaps residual corneal edema after an acute attack. Optimal timing of cataract extraction after an acute APAC attack should not be early enough to avoid significant PAS formation and late enough to avoid complications of surgery in an inflamed eye.[6] Many investigators suggest the time point of 4–6 weeks after control of an acute attack to minimize these risks.[6] We reported no serious surgical complications after phacoemulsification in our APAC cases. Previous studies demonstrated that LPI reduces forward bowing of the iris due to pupillary block in both APAC and PACG.[32] Iris prolapse during phacoemulsification is more common among patients with iris convexity. All of our APAC eyes had LPI before surgery, which may explain our low rate of complications such as iris prolapse and postoperative inflammation secondary to iris trauma.

Our study is unique in that it is the first study on effect of phacoemulsification on APAC eyes after aboring the acute attack in the Iranian population. However, potential limitations may affect the generalizability of our findings. The study population was small and may have limited power of outcome comparisons. However, using post-hoc analysis, our sample size (with type 1 error of 0.05) had a power of 81.2% to detect differences between two proportions of 40% in the LPI Only group and of 5% in the Phaco/LPI group. Moreover, there was no randomization in dividing patients. The *LPI Only* group comprised of patients who did not have visually significant cataract, and the differences in lens properties and thickness may have affected some comparisons. Another limitation is that we documented PAS by gonioscopy, which is a very subjective method. To reduce the potential for error, a single clinician performed all examinations. Finally, as this study was conducted in an Iranian population, its results may not be generalizable to other populations.

In summary, our study revealed that phacoemulsification is a safe procedure for preventing IOP rise after aborting acute primary angle closure if performed within a few weeks of the attack. The rate of IOP rise is higher among those patients treated by LPI only.

References

1. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br J Ophthalmol*. 2006;90:262–267.
2. David R, Tessler Z, Yassur Y. Long-term outcome of primary acute angle-closure glaucoma. *Br J Ophthalmol*. 1985;69:261–262.
3. Aung T, Ang LP, Chan S-P, Chew PT. Acute primary angle-closure: long-term intraocular pressure outcome in Asian eyes. *Am J Ophthalmol*. 2001;131:7–12.
4. Buckley S, Reeves B, Burdon M, et al. Acute angle closure glaucoma: relative failure of YAG iridotomy in affected eyes and factors influencing outcome. *Br J Ophthalmol*. 1994;78:529–533.
5. Lai JS, Tham CC, Chua JK, Poon AS, Lam DS. Laser peripheral iridoplasty as initial treatment of acute attack of primary angle-closure: a long-term follow-up study. *J Glaucoma*. 2002;11:484–487.
6. Lam DS, Leung DY, Tham CC, et al. Randomized trial of early phacoemulsification versus peripheral iridotomy to prevent intraocular pressure rise after acute primary angle closure. *Ophthalmology*. 2008;115:1134–1140.
7. Ang GS, Wells AP. Factors influencing laser peripheral iridotomy outcomes in white eyes: an anterior segment optical coherence tomography study. *J Glaucoma*. 2011;20:577–583.

8. George R, Paul P, Baskaran M, et al. Ocular biometry in occludable angles and angle closure glaucoma: a population based survey. *Br J Ophthalmol*. 2003;87:399−402.
9. Nongpiur ME, He M, Amerasinghe N, et al. Lens vault, thickness, and position in Chinese subjects with angle closure. *Ophthalmology*. 2011;118:474−479.
10. Mansouri M, Ramezani F, Moghimi S, et al. Anterior segment optical coherence tomography parameters in phacomorphic angle closure and mature cataractsrisk factors for phacomorphic angle closure. *Invest Ophthalmol Vis Sci*. 2014;55:7403−7409.
11. Acton J, Salmon JF, Scholtz R. Extracapsular cataract extraction with posterior chamber lens implantation in primary angle-closure glaucoma. *J Cataract Refractive Surg*. 1997;23:930−934.
12. Eslami Y, Akrami A, Fakhraie G, et al. Effect of cataract extraction on intraocular pressure in chronic angle-closure glaucoma. *Iranian J Ophthalmol*. 2007;19:6−8.
13. Latifi G, Moghimi S, Eslami Y, Fakhraie G, Zarei R, Lin S. Effect of phacoemulsification on drainage angle status in angle closure eyes with or without extensive peripheral anterior synechiae. *Eur J Ophthalmol*. 2012, 0−0.
14. Tham CC, Kwong YY, Leung DY, et al. Phacoemulsification versus combined phacotrabeculectomy in medically controlled chronic angle closure glaucoma with cataract. *Ophthalmology*. 2008;115:2167−2173. e2162.
15. Tham CC, Kwong YY, Leung DY, et al. Phacoemulsification versus combined phacotrabeculectomy in medically uncontrolled chronic angle closure glaucoma with cataracts. *Ophthalmology*. 2009;116:725−731. e723.
16. Fakhraie G, Vahedian Z, Moghimi S, Eslami Y, Zarei R, Oskouee JF. Phacoemulsification and goniosynechialysis for the management of refractory acute angle closure. *Eur J Ophthalmol*. 2011;22:714−718.
17. Husain R, Gazzard G, Aung T, et al. Initial management of acute primary angle closure: a randomized trial comparing phacoemulsification with laser peripheral iridotomy. *Ophthalmology*. 2012;119:2274−2281.
18. Roberts TV, Francis IC, Lertusumitkul S, Kappagoda MB, Coroneo MT. Primary phacoemulsification for uncontrolled angle-closure glaucoma. *J Cataract Refractive Surg*. 2000;26:1012−1016.
19. Ang LP, Aung T, Chew PT. Acute primary angle closure in an asian population: long-term outcome of the fellow eye after prophylactic laser peripheral iridotomy. *Ophthalmology*. 2000;107:2092−2096.
20. Fleck B, Wright E, Fairley E. A randomised prospective comparison of operative peripheral iridectomy and Nd: YAG laser iridotomy treatment of acute angle closure glaucoma: 3 year visual acuity and intraocular pressure control outcome. *Br J Ophthalmol*. 1997;81:884−888.
21. Alipanahi R, Sayyahmelli S. Outcomes of primary angle closure glaucoma management. *JPMA J Pak Med Assoc*. 2011;61:636.
22. Lim LS, Aung T, Husain R, Wu Y-J, Gazzard G, Seah SK. Acute primary angle closure: configuration of the drainage angle in the first year after laser peripheral iridotomy. *Ophthalmology*. 2004;111:1470−1474.
23. Eslami Y, Latifi G, Moghimi S, et al. Effect of adjunctive viscogonioplasty on drainage angle status in cataract surgery: a randomized clinical trial. *Clin Exp Ophthalmol*. 2013;41:368−378.
24. Harasymowycz PJ, Papamatheakis DG, Ahmed I, et al. Phacoemulsification and goniosynechialysis in the management of unresponsive primary angle closure. *J Glaucoma*. 2005;14:186−189.
25. Moghimi S, Latifi G, ZandVakil N, et al. Phacoemulsification versus combined phacoemulsification and viscogonioplasty in primary angle-closure glaucoma: a randomized clinical trial. *J Glaucoma*. 2014.
26. Tham CC, Leung DY, Kwong YY, Li FC, Lai JS, Lam DS. Effects of phacoemulsification versus combined phaco-trabeculectomy on drainage angle status in primary angle closure glaucoma (PACG). *J Glaucoma*. 2010;19:119−123.
27. Moghimi S, Abdi F, Latifi G, et al. Lens parameters as predictors of intraocular pressure changes after phacoemulsification. *Eye*. 2015.
28. Moghimi S, Vahedian Z, Fakhraie G, et al. Ocular biometry in the subtypes of angle closure: an anterior segment optical coherence tomography study. *Am J Ophthalmol*. 2013;155:664−673. e661.
29. Moghimi S, Vahedian Z, Zandvakil N, et al. Role of lens vault in subtypes of angle closure in Iranian subjects. *Eye*. 2014;28:337−343.
30. Moghimi S, Zandvakil N, Vahedian Z, et al. Acute angle closure: qualitative and quantitative evaluation of the anterior segment using anterior segment optical coherence tomography. *Clin Exp Ophthalmol*. 2014;42:615−622.
31. Li S-W, Chen Y, Wu Q, Lu B, Wang W-Q, Fang J. Angle parameter changes of phacoemulsification and combined phacotrabeculectomy for acute primary angle closure. *Int J Ophthalmol*. 2015;8:742.
32. Nonaka A, Iwawaki T, Kikuchi M, Fujihara M, Nishida A, Kurimoto Y. Quantitative evaluation of iris convexity in primary angle closure. *Am J Ophthalmol*. 2007;143:695−697.