**Title**

Long-Term Outcomes after Acute Primary Angle Closure: Case Series From Moorfields Eye Hospital, United Kingdom.

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**Synopsis/Precis:** Patients affected by acute primary angle closure had good vision post-treatment, with delayed presentation correlating with increased treatment needs. Phacoemulsification as a treatment can improve visual results and decrease the necessity for additional intraocular pressure (IOP) reduction treatment.

**Abstract**

Background: There is limited data regarding the morbidity and progression to primary angle closure glaucoma in those presenting with acute primary angle closure in the United Kingdom. We aim to report on the vision and intraocular pressure outcomes and treatment required after an APAC episode and to identify any risk factors that could predict worse outcomes.

Methods: A retrospective observational case series review including 117 consecutive patients (121 eyes) attending Moorfields Eye Hospital, at a tertiary referral unit in the UK, with acute primary angle closure was performed.

Results: Most patients (73%) had visual acuities of ≥ 6/12, meeting the UK driving standard, at final follow up. Only 15% (17 eyes) had severe visual impairment, as defined by the World Health Organization, in the affected eye of which 6.6 % (8 eyes) were due to glaucoma. Delayed presentation was linked to higher need for further medical treatment (OR [95% CI]=2.83 [1.09-7.40]; P=0.03). Patients who underwent phacoemulsification were at lower risk of having blindness in the effected eye (OR [95% CI] = 0.18 [0.05-0.69]; P=0.01), having elevated intraocular pressure (OR [95% CI]=0.10 [0.01-0.75]; P=0.02) or requiring further medical treatment (OR [95% CI]=0.34 [0.12-0.99]; P=0.04). Older age (OR [95% CI]= 1.26 [1.08-1.48]; P<0.01) was associated with worse visual outcome.

Conclusions: Acute primary angle closure causes low long-term visual and treatment morbidity in this largely Caucasian patient group in the United Kingdom. Phacoemulsification as a treatment may enhance visual outcomes, and reduce the need for further IOP lowering treatment.

**Key Messages**

What is already known on this topic:

- Research has been conducted on the long-term visual morbidity and progression to PACG in South-East Asian individuals following APAC, but there are limited studies in Western European populations.

What this study adds:

- APAC causes low long-term visual and treatment morbidity in a majority Caucasian cohort.
- Delayed presentation and older age were adverse prognostic factors and phacoemulsification intervention was protective against blindness.

How this study might affect, research, practice or policy:

- Phacoemulsification as a treatment may enhance visual outcomes and reduce the need for further IOP lowering treatment.

## Introduction

Acute primary angle closure (APAC) is an ocular emergency characterized by sudden symptomatic ocular hypertension as a result of total trabecular meshwork occlusion by the peripheral iris (1). Persistent high intraocular pressure (IOP) following an APAC attack can lead to irreversible glaucomatous optic neuropathy and subsequent vision loss. It has been estimated that up to 50% of eyes after an APAC episode develop primary angle closure glaucoma (PACG) (2) and that PACG will affect 34 million people by 2040 worldwide (3)

Lab-based in-vivo studies on owl monkies have demonstrated that IOP above 50mmHg for longer than 12 hours caused sustained damage to visual nerve fibres in the retina, optic nerve and their ganglion cell (4) and so prompt IOP lowering therapy is paramount. Thereafter, laser peripheral iridotomy (LPI) (5) is recommended to remove pupil block. Other treatments include argon laser peripheral iridoplasty, surgical iridectomy,laser cyclodiode (6) and early phacoemulsification (7).

Extensive research has been conducted over the last two decades on the long-term visual morbidity and progression to PACG in South-East Asian individuals following APAC, but there are limited studies inthe population of the United Kingdom (UK). The purpose of this study is to report on the outcomes of patients with APAC presenting to a mixed secondary and tertiary referral unit in London, UK. This study looked at vision, IOP and treatment outcomes after an APAC episode treated in recent years and investigated potential risk factors that are associated with worse outcomes.

## Methods

This is a retrospective observational study including 121 eyes of 117 consecutive patients who presented to Moorfields Eye Hospital NHS Foundation Trust with APAC over a 4-year period, between 1st January 2010 and 31st December 2014. Our institution is a tertiary referral centre in the UK offering a 24-hour ophthalmology service. Individuals were identified from the Emergency Department databases. This study adhered to the tenets of the Declaration of Helsinki and was approved by the Moorfields Eye Hospital Clinical Research Management and Audit Department (audit number 764).

In all cases, APAC was defined based on the presence of the following criteria (8):

1. At least two of these symptoms: ocular or periocular pain, nausea and/or vomiting, headache, a previous history of intermittent blurring of vision with haloes.
2. At least three of the following signs: conjunctival injection, corneal epithelial oedema, mid-dilated unreactive pupil, shallow anterior chamber.
3. An initial IOP higher than 21 mm Hg when measured with a Goldmann applanation tonometer and angle closure on gonioscopy (defined as iridotrabecular contact in three or more quadrants); if the status of the cornea precluded gonioscopy, then there must be prescence of shallow anterior chamber in the affected eye by slit lamp examination and occluded angle on gonioscopy in the fellow eye.

All patients with a clinical diagnosis of APAC were included. Patients presenting with secondary angle closure or previous diagnosis of any other glaucoma, and those with lack of medical records were excluded from the study. There were 236 patients identified with 119 patients excluded according to the aforementioned criteria.

All the patients were treated according to our hospital's operational APAC protocol (this is a detailed, prescriptive stepwise protocol and adherence is audited annually). In general, patients are initially medically managed, followed by bilateral Nd:YAG LPI. If this is not successful or possible, a surgical iridectomy, cyclodiode or clear lens extraction is considered based on shared decision making between the responsible glaucoma consultant and patient taking into account patient-specific ocular, medical and social factors, . If the patient's eye pressure remains elevated, or there are concerns regarding progression, glaucoma filtration surgery is then considered, as per the European Glaucoma Society guidelines.

We performed a case note analysis collecting socio-demographic data, ocular findings, investigations and interventions performed during the study period. Best-corrected visual acuity (BCVA) and IOP were recorded at presentation, plus vertical cup to disc ratio and visual field (VF) mean deviation at the penultimate and final documented reviews. VF was assessed using static automated threshold perimetry (Humphrey Instruments, program 24–2 SITA Fast, Dublin, CA). The number of IOP lowering medications and requirement for surgery for IOP control were also recorded.

Our primary aim was to determine the proportion of patients progressing to blindness (BCVA <3/60) and visual impairment (BCVA <6/18 but ≥3/60) in the affected eye as defined by the 2010 version of the World Health Organization (WHO) International Statistical Classification of Diseases and Related Health (9). The secondary

aims were to report on the final IOP for these patients and the treatment and interventions required for IOP control and determine possible predictive risk factors for the development of worse outcomes. We analysed several characteristics to identify risk factors associated with worse outcomes. These included age, gender and ethnicity, duration of symptoms before presentation, level of IOP at baseline and at discharge from the Emergency Department, and whether phacoemulsification was performed. Age was defined as as the age (in years) at time of baseline examination, higher IOP was defined per 1mmHg, and delayed presentation was defined as ≥3 days.

In this study, each eligible eye was regarded as the unit of analysis. Multivariable mixed-effect logistic regression models accounting for the multilevel structure of eyes within individuals were used to determine potential risk factors for long-term outcomes. All statistical analyses were performed using R (version 4.3.1, R Foundation for Statistical Computing). Two-sided P values< 0.05 was considered statistically significant. This case series has been reported in line with the PROCESS Guideline (10).

**Results**

From 1st January 2010 until 31st December 2014, a total of 236 consecutive subjects presented with acute angle closure to Moorfields Eye Hospital NHS Foundation Trust, London – 119 were excluded due to no medical records available (n=19) or deemed to be chronic or secondary angle closure (n=100), resulting in 117 subjects (121 eyes) of acute primary angle closure in our case series. The mean follow-up period was 58 months (range, 0 to 202 months [3 patients had no medical records after 1 month]).

The demographic data are summarised in Table 1. Eighty-five (73%) were female, 93 (79%) were of White ethnicity, and the mean age at presentation was 63 years ± 10 standard deviation (SD) (range, 33 to 91 years). There was 1 Black North African individual from Somalia and 4 subjects had bilateral disease at presentation.

Table 2 reports the presenting characteristics. 106 (88%) underwent Nd:YAG LPI in the affected eye. Whenever possible, this was performed within 24-hours from presentation in the Emergency Department, with 74% achieving an IOP of <21mmHg prior to discharge from the Emergency Department. Three subjects required initial surgical iridectomy; one of whom the iris was deemed too thick for laser and the other two of whom had cognitive impairment (dementia) making laser treatment not possible. 21 patients underwent phacoemulsification in the first 8 weeks following presentation for short-term IOP control and 4 required

cyclodiode laser in this period. There was a recurrent acute angle closure episode following iridotomy in 4 patients during the follow-up period due to LPI occlusion.

Data about the long-term IOP and medication status for the affected and fellow eye are provided in Table 3. Mean IOP at the final follow-up was 14.8 ± 4.6 and 14.4 ± 3.1 mmHg in the affected and fellow eyes respectively. Fifty-seven (50%) affected eyes had an IOP <15mmHg and only 6 (5%) affected eyes had an IOP >21mmHg. Seventy-six (66%) were treated with LPI alone and did not require topical or oral hypotensive medications for long-term IOP control in the affected eye. Ninety-three (89%) did not require topical or oral hypotensive treatment for the fellow eye.

In our cohort, 87 (73%) underwent phacoemulsification surgery and 9 required additional glaucoma surgery (4 cyclodiode laser, 3 trabeculectomy with Mitomycin C, and 2 aqueous shunt surgery with Mitomycin C; all were pseudophakic). The reason for primary aqueous shunt in the 2 patients were as follows: one had APAC in the other eye previously, which was treated at another institution with trabeculectomy that subsequently failed and the patient did not wish to have the same procedure due to the previous poor outcome; the second patient had unreliability in clinic attendance and was deemed inappropriate for the intensive post-operative care required after trabeculectomy. The mean time frame to trabeculectomy or aqueous shunt surgery was 87 months (range, 0.6 to 136).

Tables 4 represents the visual acuity, vertical cup to disc ratio and visual field damage outcomes at the penultimate and final visits for the affected eye, and the final visit for the fellow eye. Eighty-three eyes (73%) had visual acuity of Snellen 6/12 or better in the affected eye, meeting the United Kingdom driving standard for Type 1 drivers, at the final follow up. Only 17 eyes (15%) had severe visual impairment (blindness), as defined by the WHO, in the affected eye. The causes of VA <6/9 Snellen at final visit were cataract (n=3), retinal causes (epiretinal membrane, vein occlusions, macular oedema, macular degeneration, n=8), cornea decompensation (n=3), other causes (n=5, for example, dementia unable to take vision) and severe glaucoma damage in the remaining 14 eyes (12%). Seventeen patients had severe visual impairment and glaucoma was responsible for this in 8 (47%) of cases, with 2 of these patients also having mixed glaucoma and retinal pathology (diabetic retinopathy and vein occlusion). The mean vertical cup to disc ratio in the affected and fellow eye was 0.5 and 0.4 respectively. Thirty-nine eyes (35%) had a cup to disc ratio of 0.7 or more. Seventy-four eyes had visual field data available of which 51% had mild damage of less than 6dB (according to the Hodapp-Parrish-Anderson (11)) criteria in the affected eye. Mean BCVA of the affected eye at the final visit was 0.49±0.78

logarithm minimal absolute resolution (logMAR). The presenting BCVA, final BCVA and VCDR, stratified by different symptom durations, are presented in Figure 1.

Table 5 shows the multivariable logistic regression analysis for potential risk factors for more adverse outcomes. Delayed presentation was linked to higher odds of a need for further medical treatment (OR [95% CI]=2.83 [1.09-7.40]; P=0.03). Older age was associated with worse visual outcomes for BCVA worse than 6/12 in the better eye (OR [95% CI] =1.26 [1.08-1.48]; P<0.01). Phacoemulsification surgery was an independent protective factor for worse outcomes including BCVA worse than 3/60 in affected eye (OR [95% CI] =0.18 [0.05-0.69]; P=0.01), elevated IOP (OR [95% CI] =0.10 [0.01-0.75]; P=0.02) and requirement of further medical treatment (OR [95% CI] = 0.34 [0.12-0.99]; P=0.04). White ethnic background was related to better visual outcome – BCVA worse than 6/12 in the better eye (OR [95% CI] = 0.04 [0.01-0.38]; P=0.01). Patients with higher IOP at presentation had lower odds of worse outcomes including BCVA worse than 6/12 in the better eye (OR [95% CI] = 0.89 [0.79-0.99]; P=0.04) and requirement of further medical treatment (OR [95% CI] = 0.95 [0.92-1.00]; P=0.03). Patients with higher IOP at discharge from the Emergency Department were more likely to need further medical treatment (OR [95% CI] = 1.07 [1.01-1.13]; P=0.02). We have performed various subgroup analysis and these can be found in the supplementary data.

**Discussion**

In this retrospective case series, we report the 5-year outcomes of 117 patients (121 eyes) presenting with acute primary angle closure to Moorfields Eye Hospital in the UK. Overall, 73% of affected eyes had better than 6/12 vision, a mean cup to disc ratio of 0.5 and over half of eyes had less than 6dB damage on the visual field. In the affected eye, the mean final IOP was 14mmHg with 66% of subjects not requiring hypotensive medication following laser peripheral iridotomy. Importantly, we identified that undergoing phacoemulsification was associated with a very substantial reduction in long-term adverse outcomes including blindness (86% reduction), elevated IOP (93% reduction), and the subsequent requirement of medical treatment (69% reduction). Those with delayed presentation are more likely to experience adverse outcomes. Age and a global majority ethnic background are also shown as risk factors for poorer visual outcome.

Limited evidence exists regarding outcomes in the Caucasian individuals whilst over the past decade various studies have investigated the long-term outcomes in South-East Asian individuals following APAC. The long-term outcomes reported in our study are comparable to two previous published retrospective case series that

studied Caucasian patients by Andretta *et al* (12) and Fea *et al* (13), of which our series is the largest by a factor of two eyes compared to each series.

Fea *et al* (13) reported a final mean IOP of 13.4 ± 2.8 and 13.9 ± 2.6 mmHg in angle closure and fellow eyes, which is similar to our findings. Furthermore, the mean IOP at presentation in the affected eye in our sample was 52mmHg (SD, 11.85), this is in line with their study (53.2 ± 9.2 mm Hg) and previous studies in Asians, such as Lee *et al* (14) (50.2 ± 12.6). In terms of optic disc findings, 44% had cup to disc ratio of 0.5 to 0.7 and 49% affected eyes had cup to disc ratio of >0.7. In our cohort, a lower number of eyes (35%) had cup to disc ratio of >0.7. They also analysed the visual field data, showing that 49% had <6dB damage, similar to our findings at 51%. They reported a VA 0.37 ± 0.48 logMAR in the affected eyes and 0.17 ± 0.20 logMAR in the fellow eyes, which was lower than our series.

They also reported that 33% of APAC affected eyes and 54% of fellow eyes were medication-free. In our cohort, the number of patients who were medication-free was higher – 66% and 89% did not require hypotensive therapy in the APAC and fellow eyes respectively. This may be explained by the shorter duration of follow-up in their patients and the fewer numbers of phacoemulsification and glaucoma surgery in their series, in which 39% (44% of APAC eye, 32% fellow eye) underwent phacoemulsification and no patients underwent glaucoma surgery. In contrast, in our cohort, 73% underwent phacoemulsification and 9 eyes required glaucoma surgery. The percentage of glaucoma surgery reported by other authors after APAC is higher in both Caucasian and Asian patients: 16% and 63% filtration surgeries were respectively performed in the series by Andreatta (12) and Alsagoff (15). This higher rate of glaucoma surgery in these studies may be related to the lower phacoemulsification rate of 48% 12% respectively). In another Asian population described by Aung *et al* (16), 24% required hypotensive medication with 33% undergoing trabeculectomy to achieve IOP control. Fea *et al* (13) reported that the affected eyes that underwent phacoemulsification had a significantly lower use of medications. These findings corroborate the efficacy of phacoemulsification in the management of patients with PACG, described in the EAGLE trial (17)

Andreatta *et al* (12) reported a 10% rate of moderate visual impairment and 6% rate of severe visual impairment at the final follow up of which PACG was responsible for moderate visual impairment due to severe visual field constriction in 2 (4%) eyes but was not accountable for any case of blindness. In contrast, in our cohort there was a 15% proportion of severe visual impairment according to the same WHO vision criteria, of which glaucoma was accountable in 6.6% (8 patients).

Similarly, in another series of 63 Caucasian patients (18) at 6 months follow up, 67% were treatment free and 65% had a normal optic disc, with 76% having a visual acuity of 6/24 or better.

It is debateable whether or not a single episode of APAC can lead to glaucomatous optic neuropathy and factors predicting progression from APAC to PACG are also poorly defined. Regarding risk factors for worse outcomes, Andreatta *et al* (12). reported that delayed presentation to the Emergency Department and longer time to break the attack were linked to an increased risk of developing PACG. We found the same factor to be significantly associated with worse outcomes, and this has also been reported in previous studies particularly in Asian eyes (16, 19) where delay in presentation ≥3 days was a risk factor for the development of raised IOP and correlated with long-term IOP elevation and the subsequent need for further interventions after LPI. However, Fea *et al* (13) found that presenting IOP and duration of APAC attack had no statistically significant correlation with the differences in structural or functional outcomes. We found that patients with higher IOP at presentation had a 4% reduction of risk of needing further medical treatment (OR [95% CI] = 0.96 [0.92-1.00]; P=0.04), and this may be because these patients tend to have more interventions at the start of the treatment algorithm. Higher morbidity in cases suffering a longer APAC attack might be due to more extensive trabecular meshwork damage, with possible mitochondrial dysfunction and fusion of trabecular beams (20). Clinically, improved patient awareness and rapid referrals from other healthcare professionals could lead to a reduction in the incidence of PACG. In addition, APAC cases should be managed promptly according to an established protocol which should include rapid escalation to laser or surgical treatment when the attack cannot be broken with medications.

Our data are consistent with a better visual prognosis in APAC among Caucasians than Asians (21). Studies in Asians have reported that 18% of subjects were blind in the attack eye, and almost half had glaucomatous optic nerve damage (21) and 38% had significant visual field defects 6 months after the acute episode (22). Treatment of APAC with laser peripheral iridotomy is also more effective in Caucasians compared to Asian eyes. One series reported that only 42% of eyes were successfully treated with LPI alone and that with additional glaucoma medication, only 72 eyes (66%) achieved IOP control (16), whereas in our study 66% were treated successfully with LPI alone.

Our study is limited by the retrospective nature in which some data was missing with variable follow up and multiple ophthalmologists involved in the care of the patients. The patients are also from a mixed secondary and tertiary centre which may introduce selection bias and affect the generalisability of our results to a broader

Caucasian population. In addition, optic disc analysis was by cup to disc ratio based on the clinicians' judgement as the number of subjects who had objective investigations to assess the optic disc and RNFL was not sufficient for statistical testing. Thirty-nine percent of eyes did not have visual field analysis; this may be because the majority had good visual acuity and normal cup to disc ratios.

In conclusion, this study provides data on long-term outcomes of APAC in a majority Caucasion population in the UK. Our findings suggest that APAC causes a low long-term visual morbidity with the majority of patients retaining visual acuities of ≥ 6/12 with normal IOP, cup to disc ratio and visual field. Delayed presentation is a poor prognostic factor and phacoemulsification intervention in the treatment algorithm is protective against blindness, compared to those eyes in our cohort who did not undergo phacoemulsification.

**Ethics Statement:** This study adhered to the tenets of the Declaration of Helsinki and was approved by the Moorfields Eye Hospital Clinical Research Management and Audit Department (audit number 764).

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**Competing interests:** None declared.

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**Table 1** Demographic characteristics of patients (n=117) with acute primary angle closure

| | |
|---|---|
| ***Age (years)*** | |
| **Mean** | 63 |
| **Range min** | 33 |
| **Range max** | 91 |
| **SD** | 10.9 |
| ***Gender*** | |
| **Female** | 85 (73%) |
| **Male** | 32 (27%) |
| ***Ethnicity*** | |
| **White** | 93 (79%) |
| **Mixed/multiple ethnic group** | 7 (6%) |
| **Asian/Asian British/Indian** | 10 (9%) |
| **Asian/Asian British Chinese** | 1 (1%) |
| **Black/African/Caribbean/Black British** | 1 (1%) |
| **Other** | 5 (4%) |

SD, standard deviation.

**Table 2** Acute primary angle closure characteristics and management at the time of presentation

| **Presenting features** | **N** | **%** |
|---|---|---|
| ***Eye*** | | |
| **Right eye** | 60 | 49.6 |
| **Left eye** | 61 | 50.4 |
| ***Duration of symptoms before presentation (n=114)*** | | |
| **0-3 days** | 78 | 68 |
| **4-7 days** | 21 | 18 |
| **8-13 days** | 0 | 0 |
| **14-20 days** | 3 | 3 |
| **≥21 days** | 12 | 11 |
| **Median (IQR), days** | 2 (3.25) | - |
| ***Presenting intraocular pressure (n=119)*** | | |
| **21-40 mmHg** | 25 | 21 |
| **41-60 mmHg** | 66 | 56 |
| **>60 mmHg** | 28 | 24 |
| **Mean (SD), mmHg** | 51.6 (11.8) | - |
| ***Initial management in week 1 (n=121)*** | | |
| **LPI in the APAC eye** | 106 | 88 |
| **IOP at discharge ≤21mmHg** | 86 (*n=117)* | 74 |
| **IOP at discharge >21mmHg** | 31 (*n=117)* | 26 |
| **LPI in fellow eye** | 105 | 87 |
| **Repeat LPI in the APAC eye** | 21 | 17 |
| **ALPI in the APAC eye** | 2 | 2 |
| **Surgical peripheral iridectomy** | 3 | 3 |
| **Phacoemulsification for short-term IOP control*** | 21 | 17 |
| **Cyclodiode** | 4 | 3 |

APAC, acute primary angle closure; IQR, interquartile range; LPI, laser peripheral iridotomy; IOP, intraocular pressure; ALPI, argon laser peripheral iridotomy, *within 8 weeks of presentation, percentages have been rounded up to the nearest whole number

**Table 3** Long-term intraocular pressure (IOP) and medication status in affected and fellow eye

| **IOP and treatment outcomes** | **APAC eye** | | **Fellow eye** | |
|---|---|---|---|---|
| | N | % | N | % |
| ***IOP at final visit*** | ***n=115*** | | ***n=103*** | |
| **>21 mmHg** | 6 | 5 | 2 | 2 |
| **15–21 mmHg** | 52 | 45 | 50 | 49 |
| **<15 mmHg** | 57 | 50 | 51 | 50 |
| **Mean±SD (mmHg)** | 14.8 ± 4.6 | - | 14.4 ± 3.1 | - |
| **Range (mmHg)** | 2 - 35 | - | 7-22 | - |
| ***Medications for IOP control*** | ***n=115*** | | ***n=104*** | |
| **No treatment** | 76 | 66 | 93 | 89 |
| **1 topical agent** | 16 | 14 | 6 | 6 |
| **2 topical agents** | 9 | 8 | 2 | 2 |
| **3 topical agents** | 10 | 9 | 1 | 1 |
| **>4 topical agents** | 4 | 4 | 2 | 2 |
| **Long term acetazolamide** | 1 | 0.9 | - | - |
| ***Surgical interventions for IOP control after week 1*** | ***n=96*** | | ***n=60*** | |
| **Cyclodiode*** | 4 | 3 | 0 | - |
| **Trabeculectomy and MMC** | 3 | 2.5 | 0 | - |
| **Aqueous shunt implantation** | 2 | 1.7 | 0 | - |
| **Phacoemulsification** | 87** | 73 | 60 | 54 |

SD, standard deviation; MMC, mitomycin C; IOP, intraocular pressure; APAC, acute primary angle closure, *one of these patients had cyclodiode twice, percentages have been rounded up to the nearest whole number, ** 2 patients (2.3%) had posterior capsule rupture with vitreous loss requiring anterior vitrectomy

**Table 4** Clinical outcomes of acute primary angle closure and fellow eyes divided on the basis of glaucomatous damage at the penultimate and final follow-up

| **Outcome of APAC eyes at the clinic visit *(n=121)*** | **Presentation** | | **Penultimate visit: APAC eye** | | **Final outcome: APAC eye** | | **Final outcome: fellow eye** | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| ***Snellen BCVA*** | ***n=117*** | | ***n=109*** | | ***n=114*** | | ***n=103*** | |
| **>6/6** | 9 | 8 | 42 | 39 | 34 | 30 | 49 | 48 |
| **6/9 – 6/12** | 26 | 22 | 43 | 40 | 49 | 43 | 41 | 40 |
| **6/18 – 6/24** | 25 | 21 | 10 | 9 | 11 | 10 | 6 | 6 |
| **6/36 – 6/60** | 17 | 15 | 2 | 2 | 3 | 3 | 3 | 3 |
| **<6/60** | 40 | 34 | 12 | 11 | 17 | 15 | 4 | 4 |
| **6/6 - 6/18 (mild visual impairment)** | 49 | 42 | 94 | 86 | 89 | 78 | 96 | 93 |
| **<6/18 and ≥ 3/60 (moderate visual impairment)** | 28 | 24 | 3 | 3 | 8 | 7 | 3 | 3 |
| **<3/60 (severe visual impairment)** | 40 | 34 | 12 | 11 | 17 | 15 | 4 | 4 |
| **6/12 or better (DVLA cut-off)** | 35 | 30 | 85 | 78 | 83 | 73 | 90 | 87 |
| ***Vertical cup/disc ratio*** | | | ***n=106*** | | ***n=111*** | | ***n=98*** | |
| **0.0–0.49** | - | | 53 | 50 | 53 | 48 | 67 | 68 |
| **0.5–0.69** | - | | 16 | 15 | 19 | 17 | 21 | 21 |
| **0.7–0.89** | - | | 22 | 21 | 21 | 19 | 10 | 10 |
| **0.9–1.0** | - | | 15 | 14 | 18 | 16 | 0 | 0 |
| **Mean** | - | | 0.5 | - | 0.5 | - | 0.4 | - |
| ***Visual field damage (Hodapp–Parrish–Anderson)*** | | | ***n=91*** | | ***n=74*** | | ***n=86*** | |
| **No damage** | - | | 7 | 8 | 6 | 8.1 | 15 | 17 |
| **<6 dB (mild)** | - | | 46 | 51 | 38 | 51 | 61 | 71 |
| **6–12 dB (moderate)** | - | | 15 | 17 | 8 | 11 | 10 | 12 |
| **>12 dB (severe)** | - | | 23 | 25 | 22 | 30 | 0 | 0 |

BCVA, best corrected visual acuity; DVLA, Driver and Vehicle Licensing Agency; dB, decibel, percentages have been rounded up to the nearest whole number

**Table 5** Multivariable logistic regression analysis of risk factors for adverse outcomes

| Risk factors | VA in APAC eye <3/60 | | VA in better eye worse than 6/12 | | Final IOP >21 mmHg | | Further medical treatment required | | Further surgical treatment required | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P |
| Age, years | 1.06 (1.00-1.13) | 0.08 | 1.26 (1.08-1.48) | **<0.01** | 1.05 (0.96-1.14) | 0.29 | 1.03 (1.00-1.08) | 0.12 | 0.99 (0.93-1.05) | 0.68 |
| Gender, male | 0.28 (0.05-1.61) | 0.15 | 0.64 (0.10-4.19) | 0.65 | 1.15 (0.16-8.21) | 0.89 | 1.04 (0.37-2.89) | 0.94 | 1.94 (0.40-9.46) | 0.41 |
| Ethnicity, white | 0.58 (0.12-2.69) | 0.48 | 0.04 (0.01-0.38) | **0.01** | 0.39 (0.05-2.89) | 0.36 | 1.22 (0.38-3.94) | 0.74 | 3.01 (0.33-27.52) | 0.33 |
| Delayed presentation, ≥ 3 days | 1.75 (0.45-6.78) | 0.42 | 0.06 (0.01-1.05) | 0.05 | 3.56 (0.52-24.38) | 0.20 | 2.83 (1.09-7.40) | **0.03** | 2.27 (0.47-10.86) | 0.31 |
| IOP at baseline, mmHg | 0.98 (0.93-1.03) | 0.38 | 0.89 (0.79-0.99) | **0.04** | 1.02 (0.95-1.10) | 0.52 | 0.95 (0.92-1.00) | **0.03** | 1.02 (0.95-1.08) | 0.62 |
| IOP at discharge, mmHg | 1.06 (1.00-1.14) | 0.07 | 1.01 (0.92-1.12) | 0.77 | 1.06 (0.95-1.18) | 0.31 | 1.07 (1.01-1.13) | **0.02** | 1.07 (0.99-1.14) | 0.07 |
| Phacoemulsification, yes | 0.18 (0.05-0.69) | **0.01** | 2.77 (0.25-30.76) | 0.41 | 0.10 (0.01-0.75) | **0.02** | 0.34 (0.12-0.99) | **0.04** | 3.66 (0.39-34.15) | 0.25 |

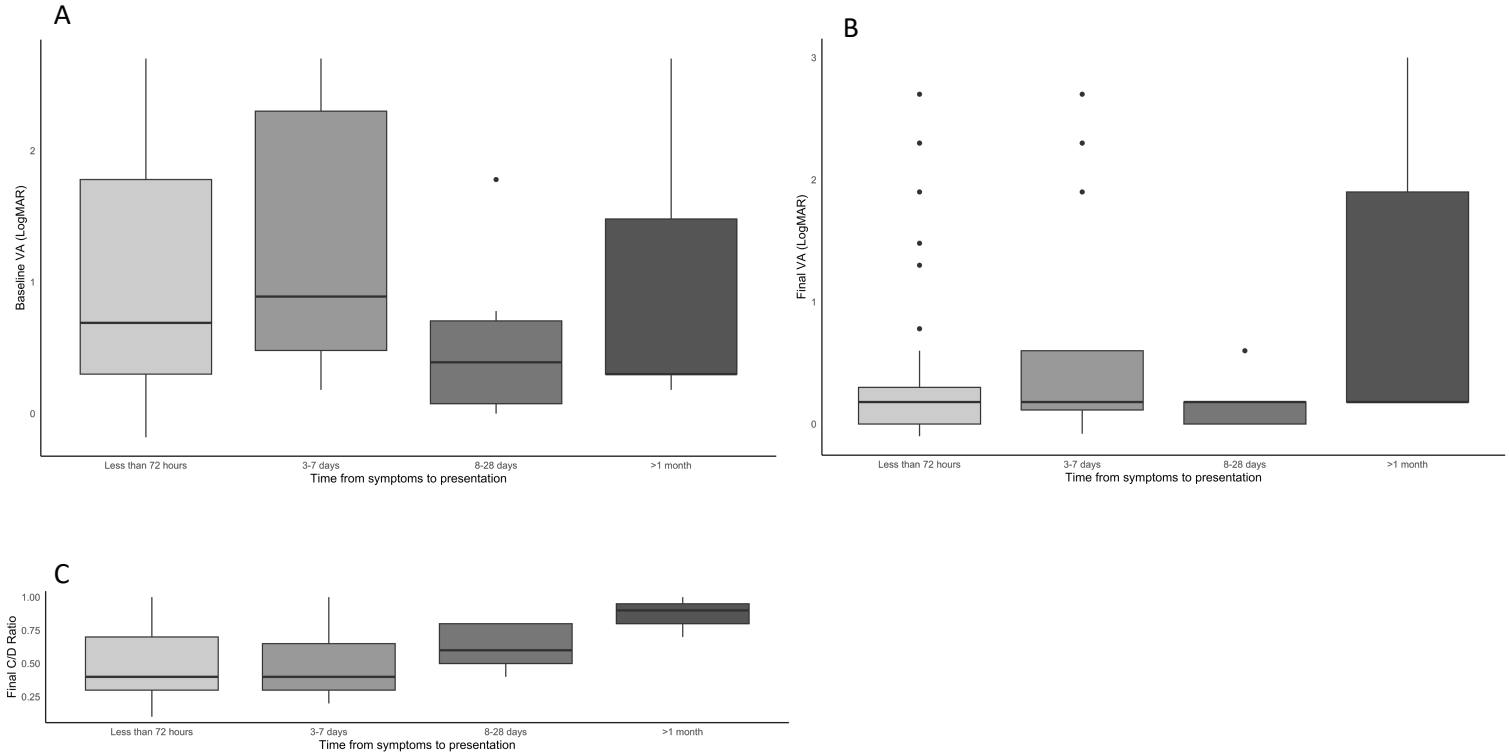
APAC, acute primary angle closure; VA, visual acuity; IOP, intraocular pressure; OR, odds ratio; CI, confidence interval.

**Bold** *indicates statistical significance.*

**Figure 1.** Presenting and final best corrected visual acuity and vertical cup to disc ratio, stratified by different symptom durations

(A). Boxplots of presenting visual acuity across different groups of duration of symptoms before presentation.
(B). Boxplots of final visual acuity across different groups of duration of symptoms before presentation.
(C). Boxplots of final Cup/Disc ratio across different groups of duration of symptoms before presentation.

Abbreviations: VA, visual acuity; logMAR, logarithm of minimal absolute resolution.



Supplementary Data

Supplementary Table 1 **Subgroup analysis comparing outcomes in eyes that underwent LPI alone, both LPI and phacoemulsification, and phacoemulsification alone**

| **Outcomes** | **LPI alone** (33 eyes) | **Phacoemulsification alone** (8 eyes) | **Both Phacoemulsification and LPI** (79 eyes) |
|---|---|---|---|
| ***Snellen BCVA*** | | | |
| >6/6 | 8 | 3 | 22 |
| 6/9 – 6/12 | 12 | 2 | 35 |
| 6/18 – 6/24 | 1 | 1 | 10 |
| 6/36 – 6/60 | 0 | 0 | 3 |
| <6/60 | 8 | 0 | 8 |
| Unknown | 4 | 2 | 1 |
| ***IOP at final visit*** | | | |
| >21 mmHg | 4 | 0 | 2 |
| 15-21 mmHg | 12 | 4 | 37 |
| <15 mmHg | 13 | 3 | 39 |
| Unknown | 4 | 1 | 1 |
| Mean±SD (mmHg) | $15.8 \pm 6.1$ | $15.0 \pm 3.1$ | $14.6 \pm 3.9$ |
| Range (mmHg) | 7 – 32 | 9 – 18 | 7 – 35 |
| ***Medications for IOP control*** | | | |
| No treatment | 15 | 5 | 54 |
| 1 topical agent | 5 | 2 | 10 |
| 2 topical agents | 4 | 0 | 5 |
| 3 topical agents | 3 | 0 | 7 |
| >4 topical agents | 2 | 0 | 2 |
| Unknown | 4 | 1 | 1 |

LPI, laser peripheral iridotomy; BCVA, best corrected visual acuity; IOP, intraocular pressure; SD, standard deviation.

Supplementary Table 2 **Subgroup analysis comparing IOP outcomes in those who had phacoemulisifcation within 8 weeks versus after 8 weeks**

| IOP at final visit | Phacoemulsification within 8 weeks (n=21) | Phacoemulsification after 8 weeks (n=66) |
|---|---|---|
| >21 mmHg | 2 | 1 |
| 15–21 mmHg | 12 | 30 |
| <15 mmHg | 7 | 35 |
| Mean±SD (mmHg) | 14.7 ± 4.6 | 14.9 ± 4.5 |
| Range (mmHg) | 8–35 | 7–22 |

IOP, intraocular pressure; SD, standard deviation.