

Efficacy and effect of intracameral adrenaline infusion on pulse rate and blood pressure during phacoemulsification in patients with dark irides

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Abstract. – OBJECTIVE: Phacoemulsification is the most common cataract surgery that needs optimum circumstances in the field of surgery. This comparative pre- and postoperative study assessed the efficacy and safety of using adrenaline in the irrigating solution as an adjunct to preoperative topical mydriatics in dark irides during Phaco surgery.

PATIENTS AND METHODS: This was a prospective observational study that enrolled 421 cataract patients (421 eyes) with dark irides, who were scheduled for Phaco surgery from January 2019 to August 2020. All patients received intraoperative irrigation of a balanced salt solution containing adrenaline. The pulse rate and systolic and diastolic blood pressure of all patients were recorded pre- and postoperatively. In addition, the presence of intraoperative floppy-iris syndrome (IFIS), need for pupil mechanical dilatation, and incidence of posterior capsular rupture were recorded.

RESULTS: The sample consisted of 421 patients (421 eyes) all had dark irides. Pulse rate and systolic and diastolic blood pressure did not significantly increase post-operatively ($p < 0.001$). Mechanical dilatation of the pupil was performed in one patient (0.24%) and seven eyes (1.66%) were found to have IFIS. There was no case of posterior capsule rupture.

CONCLUSIONS: In comparison with the use of preoperative topical mydriatics alone, adding intracameral adrenaline to the irrigation fluid maintains better pupillary dilatation throughout Phacoemulsification surgery, thereby providing better clinical outcomes in dark irides, even in those with IFIS. Its use has no incremental effect on either blood pressure or pulse rate.

Key Words:

Intracameral adrenaline, Dark irides, Phacoemulsification.

Introduction

Phacoemulsification (Phaco) is the most common cataract surgery and is one of the most in-

tricate surgeries requiring very skilled hands and optimum circumstances. Issues, such as corneal clarity, pupil size and reaction, and capsule and lens status affect the surgery and its outcomes. Pupillary constriction during Phaco is one of the major causes of posterior capsule rupture, iris damage, vitreous loss, and nucleus drop¹⁻³.

Pupillary constriction during Phaco surgery is a well-known problem in patients with intraoperative floppy-iris syndrome (IFIS), pseudoexfoliation, and diabetes mellitus. This may also occur due to extended Phaco time, excessive fluid turbulence, and iris touch^{1,4-10}.

Maintaining mydriasis throughout cataract surgery renders the operation easier and hence decreases the complication rate. It also helps in decreasing postoperative inflammation as it minimizes the chance of iris disturbance³. Topical eye drops are used preoperatively to dilate the pupil, but due to low bioavailability in the anterior chamber their effect does not help in maintaining mydriasis during surgery¹¹. Therefore, various other methods are being tried to maintain dilation of the pupil throughout the surgery. Adding nonsteroidal anti-inflammatory agents or local anesthetics has also been attempted with good results^{7,12}.

Most efforts at maintaining mydriasis during surgery have focused on the use of adrenaline in several ways. Subconjunctival and intracameral epinephrine at the start of the surgery has some advantages with the drawbacks of being less effective and short acting, respectively¹³. Adrenaline is also used at a low concentration in the irrigating solution to maintain mydriasis. Intracameral adrenaline is used at a lower dosage than topical mydriatics, which theoretically decreases the risk of systemic side effects. However, it may also spread and stimulate receptors in cardiovascular tissues, resulting in elevation of heart rate and blood pressure^{3,7,14}.

Pupils with light irides dilate better than those with dark irides, with topical dilating drops. This is a well-known observation that has been studied in detail with many hypotheses^{15,16}. This difference was addressed in a recent study on the effect of intracameral preservative-free lignocaine (1%), where the difference was found to be significant. The effect of dilatation was faster and stronger in light-colored irides, while differences in the duration of the effect were not performed¹⁷.

This comparative pre- and postoperative study assessed the efficacy and safety of using adrenaline at a low concentration in the irrigating solution as an adjunct to preoperative topical mydriatics in dark irides during Phaco surgery.

Patients and Methods

This was a prospective observational study that enrolled 421 cataract patients (421 eyes) with dark irides, who were scheduled for Phaco surgery by one surgeon, at a secondary hospital in the central area of the Kingdom of Saudi Arabia (King Khalid Hospital, Majmaah city), from January 2019 to August 2020. All patients received intraoperative irrigation of a balanced salt solution containing adrenaline (0.50 cc of 1:1,000 adrenaline mixed with 500 cc balanced salt solution yielding a 1:1,000,000 adrenaline solution).

The inclusion criteria were all patients with dark irides scheduled for cataract surgery using Phaco by one surgeon. Exclusion criteria were the use of phenylephrine topical drops for dilatation, presence of iris damage, and synechiae for any cause. All patients were preoperatively dilated using cyclopentolate and tropicamide topical drops. The operation was performed under local retrobulbar anesthesia, and Phaco was performed using the INFINITI® Vision System.

The pulse rate (PR) and systolic and diastolic blood pressure (SBP, DBP) of all patients were recorded pre- and postoperatively. Demographics details and the presence of IFIS, need for pupil mechanical dilatation, and incidence of posterior capsular rupture were recorded. Ethical approval was granted by the Central Institutional Review Board of Saudi Arabia, (log number 20-144E). The research followed the tenets of the Declaration of Helsinki, and informed consent was obtained from all participants.

Power analysis and sample size software (PASS) were used to calculate the sample size. A

sample size of 421 achieves 90% power to detect a clinically meaningful difference of 0.08, with a known standard deviation of 0.506 and significance level of 0.05. The calculation was further confirmed by placing the aforementioned values in the following formula that yielded the same number of patients i.e., 421.

$$n = \frac{\sigma_d^2 (Z_\beta + Z_{\alpha/2})^2}{\text{difference}^2}$$

where:

n = sample size

σ = standard deviation of the within-pair difference
difference = clinically meaningful difference

Z_β = corresponds to power (1.28 = 90% power)

$Z_{\alpha/2}$ = corresponds to two-tailed significance level (1.96 for $\alpha = .05$)

The data were entered and analyzed using RStudio for Windows Version 26.0: R Core Team (2020), Vienna, Austria. Frequencies and percentages are reported for the qualitative variables. The mean and standard deviation are reported as measures of dispersion for the quantitative variables. The paired-sample *t*-test was applied to compare the before and after differences between PR and SBP and DBP. A *p*-value of <0.05 was considered statistically significant.

Results

The sample consisted of 421 patients (421 eyes) who met the inclusion criteria; 24 patients were excluded due to the use of phenylephrine preoperatively, iris damage, or synechiae. All the patients had dark irides. Most of the patients were men (n=229; 54.4%) compared with women (n=192; 45.6%). The mean age of the patients was 65.28 ± 4.21 years. The majority of the patients (n=295; 70.07%) were more than 60 years old, whereas around (n=126; 29.93%) belonged to the age group of 40–60 years.

The median preoperative and the postoperative SBP was 155 (136-174) mmHg, and 149 (135-166) mmHg respectively. A significant difference was observed between the pre- and postoperative SBP ($p < 0.001$), showing a significant reduction in the postoperative SBP. Similarly, the median preoperative DBP and the median postoperative DBP were 80 (72-88.5) mmHg and 79 (71-85.5) mmHg,

Table I. Difference in median between pre- and postoperative SBP, DBP and PR.

	Pre-op Median (25 th – 75 th Percentile) n = 421	Post-op Median (25 th – 75 th Percentile) n = 421	p-value
SBP†	155 (136-174)	149 (135-166)	< 0.001*
DBP‡	80 (72-88.5)	79 (71-85.5)	< 0.001*
PR¥	73 (66-83)	72 (66-80)	< 0.001*

*, Statistically significant at 5% level of significance; †, Systolic Blood Pressure; ‡, Diastolic Blood Pressure; ¥, Pulse Rate.

respectively. Again, a statistically significant difference was observed between the pre-and post-operative DBP ($p < 0.001$), showing a significant reduction in the postoperative DBP. The median preoperative and postoperative PR was 73 (66-83) and 72 (66-80) bpm, respectively. Likewise, a significant difference was observed between the pre-and postoperative median PR ($p < 0.001$), showing a significant reduction in the median postoperative PR. The results are shown in Table I.

SBP, DBP, and PR were further categorized into “increased” and did not increase after the use of adrenaline. The results presented in Table II show that in more than two-thirds (67.2%) of the patients, postoperative SBP did not increase, and this difference was statistically significant ($p < 0.001$). When postoperative DBP was analyzed, most of the patients’ postoperative DBP (60%) did not increase, which was also statistically significant ($p < 0.001$). Similar results were obtained when changes in postoperative PR were compared. The majority of the patients’ postoperative PR (63.2%) did not increase, and the difference was again significant ($p < 0.001$).

Mechanical dilatation of the pupil was performed in one patient (0.24%) using iris hooks. Seven eyes (1.66%) were found to have IFIS that was not controlled by the use of intracameral adrenaline. There was no case of posterior capsule rupture in our study.

Discussion

Phaco is the most commonly performed cataract surgery. The routine uses of topical mydriatics on the ocular surface to dilate the pupil before Phaco surgery often results in slow penetration through the cornea, and mydriasis is delayed with significant systemic absorption, which may increase the risk of cardiovascular side effects¹⁸⁻²².

Intracameral mydriatics have fewer adverse systemic effects than topical mydriatics, and they do not need to cross any tissue to come into contact with the target tissue²³. Furthermore, it was found that 1.5% intracameral phenylephrine is very effective in relieving IFIS²⁴. Adding local anesthetic with intracameral mydriatics also proved to be very effective in dilating the pupil at the beginning of the Phaco surgery²⁵. Theoretically, these substances may not remain throughout the procedure and could be washed out, with their effect fading away. Instead, adding mydriatics to the irrigating solution maintains the intracameral concentration at the therapeutic level over the entire duration of the surgery. In addition, the dose needed will be less than when it is administered in a single shot at the beginning of the procedure²⁶. Therefore, adrenaline alone was mixed with the irrigation solution to reach sustainable

Table II. Increment in postoperative SPB, DBP and PR.

	Post-op Increased n (%) = 421	Post-op Not Increased n (%) = 421	p-value
SBP†	138 (32.8)	283 (67.2)	< 0.001*
DBP‡	163 (38.7)	268 (61.3)	< 0.001*
PR¥	155 (36.8)	266 (63.2)	< 0.001*

*, Statistically significant at 5% level of significance; †, Systolic Blood Pressure; ‡, Diastolic Blood Pressure; ¥, Pulse Rate.

mydriasis throughout the cataract surgery^{27,28}. In addition, intracameral pupil dilatation alone without topical agents has been suggested since 2003 by Cionni et al²⁹. They used lidocaine 1% with the addition of adrenaline to the irrigation fluid without using preoperative mydriatic eye drops, thereby providing adequate dilatation. Thus, intracameral mydriatics could be used alone or as an adjunct to the topical treatment⁴.

In our study, out of 421 eyes with dark irides operated using Phaco, only one case (0.24%) required mechanical dilation of the pupil using iris hooks. Considering that all the surgeries were performed by the same surgeon, this provides valuable information regarding the good mydriatic effect of adrenalin in the perioperative period on dark irides. This is because isolating the surgeon factor results in the inference being dependent only on the effect of the drug. Many other scholars³⁰ have also reported this advantage. Furthermore, our results showed less frequent use of iris hooks compared with Alikma et al³¹, who reported 0.7% use in 3020 Phaco surgeries using diluted adrenaline into the anterior chamber after the first side entrance to the cornea.

The overall reported prevalence of IFIS is 1.1-12.6%⁹. In our study, there was occurrence of floppy iris in 7 (1.7%) patients. Although there was a good amount of dilatation that did not necessitate mechanical dilatation, the adrenaline use did not prevent the iris movement in those cases; this is consistent with Tak-maze and Can³² who found that adrenaline usage did not change the IFIS occurrence rate but was effective in preventing miosis. Nuzzi et al¹⁰ further categorized it to the effect of adrenaline on mild and severe forms of IFIS. They found that it is more effective in the mild form, than in the severe form, with uneventful recovery in all patients.

In our study, using irrigation/aspiration solution containing adrenaline (0.50 cc of 1:1,000 adrenaline mixed with 500 cc balanced salt solution yielding a 1:1,000,000 adrenaline solution) could maintain adequate mydriasis during the surgery without significant increase of BP or HR from baseline ($p < 0.001$). The probable reason for this is the limited absorption and low concentration of adrenaline, which fails to trigger any systemic cardiovascular changes. Williams et al³⁰ also reported a similar finding in a study conducted in Riyadh. The findings of this study were consistent with other studies con-

ducted outside Saudi Arabia with similar objectives, which noted no significant effect on blood pressure (BP) or PR^{3,33,34}.

The rise in BP and PR in one-third of the patients was most likely surgically induced neurogenic hypertension³. In the same way, the reason for significant decrease in the median BP and PR postoperatively in our study was probably due to the relief of the surgically induced neurogenic hypertension at the end of the surgery and/or the use of sedation in anxious patients.

To the best of our knowledge there was no previous work addressing the efficacy and cardiopulmonary safety of intraoperative irrigation of a balanced salt solution containing adrenaline specifically on patients with dark irides.

One drawback of this study was the lack of data on pupil diameter. However, the exact pupil diameter is not the main goal; rather, the feasibility of performing the surgery with minimal complications regardless of the exact size of the iris is, which was addressed here.

Conclusions

In comparison with the use of preoperative topical mydriatics alone, adding intracameral adrenaline to the irrigation fluid maintains better pupillary dilatation throughout Phaco surgery, thereby providing better clinical outcomes in dark irides, even in those with IFIS. Its use has no incremental effect on either BP or PR.

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Any data and materials related to this study are available upon request from the Principal Investigator (Khalid Alabdulwahhab, e-mail: k.alabdulwahhab@mu.edu.sa).

Conflict of Interest

The Authors declare that they have no conflict of interests.

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