Original Article

# Comparative study to assess the effect of ropivacaine and a mixture of lidocaine and bupivacaine on intraocular pressure after peribulbar anesthesia for cataract surgery

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**Purpose:** To compare the efficacy of ropivacaine with a mixture of lidocaine and bupivacaine in peribulbar anesthesia for cataract surgery, in terms of post-block intraocular pressure (IOP). **Methods:** A one-year comparative study was done to compare two anesthetic solutions in peribulbar anesthesia for cataract surgery, from January 2020 to December 2020 at a tertiary health care hospital. Two hundred patients (40–70 years of age) planned for small-incision cataract surgery with posterior chamber intraocular lens (IOL) implantation under peribulbar anesthesia were included in the study. A single-site inferotemporal injection was given till a total eyelid drop was observed. The IOP was measured at four time-points: before block (control), 1-, 5-, and 15-minute post-block with a tonometer. **Results:** The 1-minute post-block mean IOP in both the groups was higher than the baseline levels. This reflected raised intraorbital pressure secondary to peribulbar injection of local anesthetic. However, the rise in 1-minute post-block IOP was significantly less in the ropivacaine group. The 5- and 15-min post-block mean IO*P* values in the ropivacaine group were significantly lower than the corresponding values of the lidocaine-bupivacaine group and baseline (control) ropivacaine values. **Conclusion:** The results of this study support that ropivacaine as a local anesthetic drug for peribulbar block for small-incision cataract surgery can be a suitable alternative to the lidocaine–bupivacaine combination. Studies involving a larger sample size are required to consider ropivacaine as a superior drug to the lidocaine–bupivacaine combination.

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Worldwide, cataract is the most common treatable cause of visual impairment.[1] The sole treatment for cataract is its surgical removal, which is a common ophthalmic surgical procedure and like most orbital surgeries, cataract surgery is also routinely performed under regional anesthesia.[2]

The evolution and acceptability of peribulbar anesthesia are linked to the evolution of cataract surgery. When larger incisions at the sclero-limbal region were required in the past, complete anesthesia or retrobulbar anesthesia was the preferred anesthetic modality. As phacoemulsification, clear cornea incision, and small-incision cataract surgery (SICS) grew more common, the trauma and discomfort associated with cataract surgery became less severe, and various anesthetic techniques gained acceptance.[3]

Not only the technique of peribulbar block but also the local anesthetic used can affect the outcome of the surgery in terms of intraoperative complications, patient compliance, and the level of surgeon comfort.

Lidocaine is a commonly used local anesthetic with a rapid onset of action.[4] Bupivacaine, another local anesthetic drug, provides a long duration of action with high-quality sensory blockade but has a comparatively slow onset. Thus, it is combined with the faster-acting lidocaine for peripheral nerve blocks.[5]

A newer and long-acting local anesthetic is ropivacaine which has comparable or superior neuronal blocking potential to bupivacaine.[6]

This study compares 0.75% ropivacaine with a 1:1 mixture of 2% lidocaine with 0.50% bupivacaine and assesses their efficacy for the peribulbar block in cataract surgeries in terms of the post-block intraocular pressure (IOP).

## Methods

A one-year comparative study involving two hundred patients was done between January 2020 to December 2020. The study was approved by the institutional ethics committee and is consistent with the tenets of the Declaration of Helsinki. Patients 40–70 years of age attending the ophthalmology outpatient department (OPD) who were scheduled to undergo SICS with posterior chamber intraocular lens (PCIOL) implantation under peribulbar anesthesia were the source of data.

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Inclusion criteria were uncomplicated cataract, normal IOP (7–21 mmHg),[7] normal baseline electrocardiogram (ECG) rhythm, and American Society of Anesthesiologists (ASA) grade I, II, III.

Exclusion criteria were patients with profound cognitive impairment,[8] apprehension, requiring sedatives and analgesics,[8] allergy to hyaluronidase, lidocaine, bupivacaine, and ropivacaine, any preceding eye disorder other than cataract,[8] and unwillingness to participate in the study.

Patients were randomized into two groups of 100 each by simple random sampling to receive a peribulbar injection from either one of the following solutions: group A - 0.75% ropivacaine with 75 units of hyaluronidase or group B - a mixture of 2% lidocaine with 0.50% bupivacaine with 75 units hyaluronidase. On the day before surgery, a detailed history of the patient was taken, and a general physical examination, ophthalmologic examination, and investigations were done.

Vital parameters such as pulse rate, blood pressure, and random blood sugar levels were assessed. Ophthalmic examination was done by the investigator.

Patients did not undergo fasting and did not receive any anesthetic pre-medication, perioperative sedation, or supplementary oxygen. On the day of surgery, before the procedure tropicamide 0.8% (weight/volume) and phenylephrine 5% (weight/volume) dilating eye drops were instilled in the eye to be operated. A test dose of the anesthetic drug was given for sensitivity. On the day of surgery, pre-block (control) IOP were measured with a tonometer.

### Technique of peribulbar block

The eye to be operated was identified and painted and draped with 10% betadine solution. A 26-gauge (G) 0.5-inch disposable needle was used.

Site of injection: The point between medial 2/3$^{rd}$ and lateral 1/3$^{rd}$ of lower orbital margin adjacent to infraorbital notch.

With the bevel of the needle facing toward the globe, the needle was cautiously advanced parallel to the orbital floor and no redirection was done as in the retrobulbar block. Care was taken so that the hub of the needle did not go beyond the inferior orbital rim. Correct positioning of the needle was confirmed by comparing the range of eye movement to the baseline values to exclude tethering of the globe.[9] After negative aspiration for blood, up to 10 mL of the local anesthetic agent was injected over 30–40 seconds.[10] The volume of local anesthetic drug that produced total upper eyelid drop, i.e. sufficient depression of the eyelid to cover the whole of the cornea, was considered as the end point of injection.[9] After injection at the inferotemporal quadrant, the globe was massaged with the middle 3 fingers placed over a sterile gauze pad. Gentle pressure was applied using the middle finger placed directly over the eyeball for 1 minute (min). For every 30 seconds, the pressure was released for 5 seconds to allow for vascular pulsations to occur.[11] IOP was measured at four time-points: before block (control), one minute after block, five minutes after block, and 15 minutes after block with a tonometer.[12]

### Statistical analysis

The collected data were analyzed by calculating mean and standard deviation for continuous quantitative variables, unpaired student's *t*-test for inter-group continuous variables, and student's paired *t*-test for two quantitative variables within a group. Suitable graphs were used to depict the comparison. For all the tests, a *P* value of less than 5% (0.05) was considered significant.

## Results

In this study, 200 patients were included, 100 in group A, who received ropivacaine as the local anesthetic, and 100 in group B, who received a mixture of lidocaine and bupivacaine as the local anesthetic. The data obtained were tabulated as below:

### Demographic data

Twelve percent of patients belonged to age group of 41–50 years, 33% belonged to 51–60 years, and 55% belonged to 61–70 years [Table 1]. Mean age was 60.46 years. Out of 200 patients, 100 were men and 100 were women. And in both groups, men were 50 and women were 50 [Table 2].

The volume of anesthetic injected and the post-block IOP within the respective groups was not significant ($P > 0.05$) at any time-point [Table 3].

Pre-block (control) mean IOP in group A was 13.86 ± 3.06 mmHg and in group B was 13.13 ± 3.01 mmHg and it was not significant. The 1-min post-block IOP mean in both groups was higher than their baseline levels (pre-block) which in group A was 14.91 ± 4.14 mmHg and in group B was 15.50 ± 4.26 mmHg; but it was not significant. However, the rise in 1-min post-block IOP was significantly less in the ropivacaine group (group A). The 5-min and 15-min post-block mean IOP values in group A were significantly lower than the corresponding group B values and the baseline group A values [Table 4, Graph 1].

In group A, the pre-block (control) IOP was 13.86 ± 3.06 mmHg and the IOP 15 min after the block was 13.31 ± 3.17 mmHg and it was significantly lower (0.0016*), with an effect size of 0.2880. In group B, the pre-block (control) IOP was 13.10 ± 3.01 mmHg and the IOP 15 mins after the block was 16.68 ± 4.84 mmHg and it was significantly higher (0.0001*), with an effect size of 0.5440 [Table 5, Graph 2].

## Discussion

In our study, we included 200 patients. They were assigned to either group A or group B using a simple random sampling method. Group A patients received ropivacaine 0.75% as the

**Table 1: Age distribution**

| Age Groups | Group A (*n*=100) | % | Group B (*n*=100) | % | Total | % |
|---|---|---|---|---|---|---|
| 41-50 years | 10 | 10.00 | 14 | 14.00 | 24 | 12.00 |
| 51-60 years | 27 | 27.00 | 39 | 39.00 | 66 | 33.00 |
| 61-70 years | 63 | 63.00 | 47 | 47.00 | 110 | 55.00 |

local anesthetic for peribulbar anesthesia, whereas group B patients received a mixture of bupivacaine 0.5% with lidocaine 2% combined in a 1:1 ratio as the local anesthetic for peribulbar anesthesia. Each group had 100 patients.

Most patients were in the age group of 61–70 years in either group with a mean age of 60.46 ± 7.39 years. Gupta *et al.*[13] conducted a similar study where the mean age of the patients was 64.2 years.

Coincidently, both groups had 50 males and 50 females. In a study by Nociti *et al.*,[14] 55.0% were males and 45.0% were females which was not statistically significant.

According to Frow *et al.*,[9] there are many methods to determine how much local anesthetic drug to inject for peribulbar anesthesia and akinesia. But there is no universally recognized and clinically consistent way to know the end-point of the local anesthetic volume sufficient to provide akinesia and anesthesia. In our study, a variable volume of a local anesthetic agent (<10 mL) was injected depending on the amount of filling of orbit seen during injection and the rate of onset of ptosis (total upper eyelid drop).[10,15] In our study, the volume of the anesthetic agents used in both groups was similar and the results were not statistically significant.

In our study, hyaluronidase was added to both groups as many studies have proven that hyaluronidase improves the quality of the block.[16–18]

According to most studies, the post-block IOP rise is positively linked to the increasing volumes of local anesthetic solutions used.[19,20] However, in our study, we did not find any such correlation. The volume of anesthetic injected and the post-block IOP within the respective groups was not significant. This suggests that the volume of local anesthetic solution injected is not linked to the IOP rise. This might be because we have not used exceptionally large volumes of the anesthetic solution. The results of our study are comparable to a similar study conducted by Frow *et al.*[9]

Mean values of IOP before block were similar between the two groups ($P > 0.05$, independent *t*-test) which is also in agreement with a study done by Özcan *et al.*[12] that had a

**Table 2: Gender distribution**

| Gender | Group A (*n*=100) | Group B (*n*=100) | Total | % |
|---|---|---|---|---|
| Male | 50 | 50 | 100 | 50.00 |
| Female | 50 | 50 | 100 | 50.00 |
| Total | 100 | 100 | 200 | 100.00 |

**Table 3: Correlation between volume of anesthetic agent with IOP (mmHg) at 1 min, 5 min, and 15 min by one-way ANOVA**

| Groups | Volume of Anesthetic | IOP 1 min | | IOP 5 mins | | IOP 15 mins | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| Group A | 3-6 | 14.23 | 4.04 | 14.15 | 3.83 | 13.69 | 3.25 |
| | 7-8 | 14.87 | 4.58 | 13.23 | 3.01 | 12.74 | 2.84 |
| | 9-10 | 15.09 | 3.97 | 14.00 | 3.56 | 13.54 | 3.34 |
| | Total | 14.91 | 4.14 | 13.78 | 3.42 | 13.31 | 3.17 |
| *F* | | 0.2248 | | 0.5950 | | 0.7284 | |
| *P* | | 0.7991 | | 0.5536 | | 0.4853 | |
| Group B | 3-6 | 16.00 | 2.45 | 16.58 | 3.03 | 15.75 | 5.17 |
| | 7-8 | 15.17 | 3.73 | 15.62 | 3.89 | 15.90 | 3.56 |
| | 9-10 | 15.56 | 4.80 | 16.19 | 4.45 | 17.25 | 5.28 |
| | Total | 15.50 | 4.26 | 16.07 | 4.12 | 16.68 | 4.84 |
| *F* | | 0.1710 | | 0.2843 | | 1.0188 | |
| *P* | | 0.8431 | | 0.7532 | | 0.3649 | |

*$P<0.05$

**Table 4: Comparison of group A (ropivacaine) and group B (lidocaine–bupivacaine) with IOP (mmHg) at different treatment times by independent *t*-test**

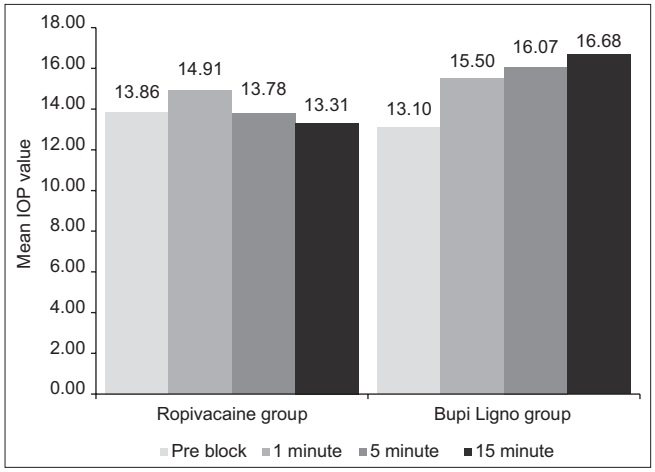
| Treatment Times | Group A | | Group B | | Mean Difference | *t* | *P* |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| Pre-block IOP (control) | 13.86 | 3.06 | 13.10 | 3.01 | 0.76 | 1.7701 | 0.0783 |
| Post-block IOP | | | | | | | |
| 1 min | 14.91 | 4.14 | 15.50 | 4.26 | −0.59 | −0.9924 | 0.3222 |
| 5 min | 13.78 | 3.42 | 16.07 | 4.12 | −2.29 | −4.2728 | 0.0001* |
| 15 min | 13.31 | 3.17 | 16.68 | 4.84 | −3.37 | −5.8259 | 0.0001* |
| Pre-block 1 min | −1.05 | 2.30 | −2.40 | 3.13 | 1.35 | 3.4743 | 0.0006* |
| Pre-block 5 min | 0.08 | 1.55 | −2.97 | 2.83 | 3.05 | 9.4454 | 0.0001* |
| Pre-block 15 min | 0.55 | 1.69 | −3.58 | 3.93 | 4.13 | 9.6626 | 0.0001* |

*$P<0.05$

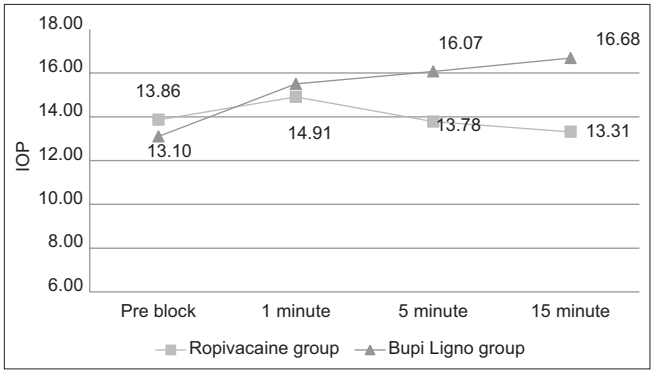
**Table 5: Comparison of different treatment times with IOP (mmHg) in group A (ropivacaine) and group B (lidocaine–bupivacaine) by dependent *t*-test**

| Group | Treatment Times | Mean | SD | Mean Diff. | SD Diff. | Paired *t* | *P* | Effect Size |
|---|---|---|---|---|---|---|---|---|
| Group A | Pre-block IOP | 13.86 | 3.06 | | | | | 0.2880 |
| | 1 min | 14.91 | 4.14 | −1.05 | 2.30 | −4.5694 | 0.0001* | |
| | Pre-block IOP | 13.86 | 3.06 | | | | | |
| | 5 min | 13.78 | 3.42 | 0.08 | 1.55 | 0.5167 | 0.6065 | |
| | Pre-block IOP | 13.86 | 3.06 | | | | | |
| | 15 min | 13.31 | 3.17 | 0.55 | 1.69 | 3.2545 | 0.0016* | |
| | 1 min | 14.91 | 4.14 | | | | | |
| | 5 min | 13.78 | 3.42 | 1.13 | 1.99 | 5.6838 | 0.0001* | |
| | 1 min | 14.91 | 4.14 | | | | | |
| | 15 min | 13.31 | 3.17 | 1.60 | 2.53 | 6.3226 | 0.0001* | |
| | 5 min | 13.78 | 3.42 | | | | | |
| | 15 min | 13.31 | 3.17 | 0.47 | 1.07 | 4.4010 | 0.0001* | |
| Group B | Pre-block IOP | 13.10 | 3.01 | | | | | 0.5440 |
| | 1 min | 15.50 | 4.26 | −2.40 | 3.13 | −7.6594 | 0.0001* | |
| | Pre-block IOP | 13.10 | 3.01 | | | | | |
| | 5 min | 16.07 | 4.12 | −2.97 | 2.83 | −10.4813 | 0.0001* | |
| | Pre-block IOP | 13.10 | 3.01 | | | | | |
| | 15 min | 16.68 | 4.84 | −3.58 | 3.93 | −9.1189 | 0.0001* | |
| | 1 min | 15.50 | 4.26 | | | | | |
| | 5 min | 16.07 | 4.12 | −0.57 | 2.48 | −2.2991 | 0.0236* | |
| | 1 min | 15.50 | 4.26 | | | | | |
| | 15 min | 16.68 | 4.84 | −1.18 | 4.31 | −2.7354 | 0.0074* | |
| | 5 min | 16.07 | 4.12 | | | | | |
| | 15 min | 16.68 | 4.84 | −0.61 | 2.65 | −2.3051 | 0.0232* | |

*$P<0.05$ The effect size is more in group B which indicates a larger IOP variation




**Graph 1:** Comparison of group A and group B with IOP (mmHg) at different treatment times




**Graph 2:** Comparison of different treatment times with IOP (mmHg) in group A and group B

similar mean pre-block IOP between the two groups ($P > 0.05$, Mann–Whitney *U* test).

A study by Frow *et al.*[9] showed that in all eyes, the mean (95% confidence limits) increase in IOP over baseline immediately post-injection was 6.9 (4.9–8.8) mmHg ($P < 0.00001$). The present study showed a significant difference between the control (pre-block values) and 1-min post-block IOP values. All eyes (both groups) had an increase in IOP over baseline (control) at 1 min after peribulbar injection and this increase was significantly less in the ropivacaine group when compared to the lidocaine-bupivacaine group.

Overall, the mean readings of IOP post-block were significantly less in group A (ropivacaine) in comparison to group B (lidocaine-bupivacaine). In our study, group A's 1-min post-block IOP was 14.91 ± 4.14 mmHg which was not statistically significant in comparison to group B which was 15.50 ± 4.26 mmHg. This was not in agreement with a study done by Nociti *et al.*,[14] in which variation in IOP was different in both the groups, that is, ropivacaine and bupivacaine for a peribulbar block. In their study, in the ropivacaine group the mean values obtained at all the three time-points after the block were

significantly lower than the controls. This effect was probably due to vasoconstriction produced by ropivacaine, leading to smaller intraocular blood volume,[8,14] but in the bupivacaine group, the mean value of IOP rose significantly 1-min after block and was lower than control only 15 min after block.

In our study, the mean values of IOP after block were significantly lower in the ropivacaine group in comparison to the lidocaine–bupivacaine group at 5 min and 15 min time-points after block. These results were in agreement with the studies done by Nociti *et al*.[14] and Govêia, Magalhães.[21]

In a study done by Olmez *et al*.,[15] the authors compared ropivacaine with a mixture of lidocaine–adrenaline and observed that there were no significant differences in IOP levels between the two groups at three times-points, that is, 1 min, 5 min, and 10 min. However, the IOP levels in the ropivacaine group at 10 min were significantly lower than their baseline values. A transient rise in IOP can be due to the peribulbar block itself secondary to the increase in orbital pressure. But as the extraocular muscles relax, there is a rapid fall in IOP.[15] As already discussed above, this effect of ropivacaine could be due to vasoconstriction produced by it.[15] Another cause of lower IOP levels seen in the ropivacaine group can be attributed to its property of high lipid solubility which allows it to diffuse through tissues faster than lidocaine.[15] In our study, we had highly lipid-soluble ropivacaine which was compared with a mixture of bupivacaine (which is also highly lipid-soluble) and lidocaine (less lipid-soluble). So higher post-block IOP in group B (lidocaine–bupivacaine group) can be attributed to the less lipid solubility of lidocaine. Özcan *et al*.[12] observed that the lidocaine–bupivacaine combination increased IOP from 15.1 ± 2.5 mmHg to 17.8 ± 2.5 mmHg after the peribulbar anesthesia, whereas ropivacaine decreased IOP from 15.8 ± 2.3 to 13.5 ± 2.3 mmHg.

## Conclusion

The results of this study support that ropivacaine was more effective than the lidocaine–bupivacaine combination for peribulbar anesthesia for cataract surgery, as it adequately lowers the IOP and thus prevents the potential side-effects resulting from high post-block intraocular pressures seen in the latter group.

Therefore, ropivacaine as a local anesthetic drug for the peribulbar block in small-incision cataract surgery can be a suitable alternative to the lidocaine-bupivacaine combination. Further studies involving a larger sample size can be done to consider ropivacaine as a superior drug over the lidocaine–bupivacaine combination for peribulbar block in small-incision cataract surgery.

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### Conflicts of interest

There are no conflicts of interest.

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