ORIGINAL RESEARCH

The Impact of Combined Anesthesia Approaches in Glaucoma Surgery: A Comparative Study Between Local Anesthesia and Sedation versus General Anesthesia

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ABSTRACT

Aim: This study aimed to compare the impact of combined anesthesia approaches in glaucoma surgery, specifically focusing on local anesthesia and sedation (LAS) versus general anesthesia (GA). **Materials and Methods:** A total of 120 patients diagnosed with glaucoma and scheduled for surgical intervention were randomly assigned to either the LAS group or the GA group. In the LAS group, local anesthesia was administered via peribulbar or retrobulbar blocks, combined with mild sedation using intravenous midazolam and fentanyl. The GA group received full anesthesia with endotracheal intubation, maintained by a mixture of volatile anesthetics and intravenous agents. Preoperative assessments including visual acuity, intraocular pressure (IOP), and baseline eye examination were documented for all patients. Intraoperative variables such as anesthesia duration, surgical time, and complications were monitored. Postoperative recovery was evaluated by assessing recovery time, pain levels, nausea, vomiting, and respiratory complications. **Results:** The demographic and baseline characteristics were similar between the two groups, suggesting comparability. Intraoperative anesthesia duration was significantly shorter in the LAS group (25.4 ± 5.2 minutes) compared to the GA group (40.1 ± 6.8 minutes) ($p<0.001$), while surgical time was similar between both groups. Postoperative recovery time was significantly shorter in the LAS group (20.3 ± 4.4 minutes) compared to the GA group (60.2 ± 12.3 minutes) ($p<0.001$). Pain levels, measured by the Visual Analog Scale (VAS), were lower in the LAS group (3.2 ± 1.1) compared to the GA group (4.8 ± 1.3) ($p<0.001$). The incidence of nausea and vomiting was significantly lower in the LAS group (6.7%) than in the GA group (20%) ($p=0.04$). Respiratory complications occurred in 0% of the LAS group compared to 6.7% in the GA group ($p=0.05$). Visual acuity and IOP were similar between the two groups postoperatively. Complications and overall patient satisfaction were also comparable, though the LAS group showed a slightly higher satisfaction score (8.5 ± 1.2 vs. 7.8 ± 1.5, $p=0.09$). **Conclusion:** This study demonstrates that local anesthesia with sedation (LAS) provides significant advantages over general anesthesia (GA) in glaucoma surgery. LAS is associated with shorter recovery times, reduced postoperative pain, and fewer adverse effects, such as nausea and vomiting, compared to GA. Both anesthesia approaches resulted in comparable visual outcomes and IOP regulation. These findings support the use of LAS as a safer and more efficient option for glaucoma surgery, with potential benefits in terms of patient comfort, safety, and overall satisfaction.

Keywords: Glaucoma surgery, local anesthesia, sedation, general anesthesia, postoperative recovery

INTRODUCTION

Glaucoma surgery, aimed at reducing intraocular pressure and preventing vision loss, is a critical treatment for patients with advanced glaucoma. Given the importance of maintaining optimal intraocular pressure control and the complexity of surgical interventions, anesthesia plays a crucial role in the success of glaucoma surgeries. The choice of anesthesia method can significantly affect surgical outcomes, patient comfort, and the overall experience.

Among the different anesthetic options available, local anesthesia with sedation and general anesthesia are two commonly employed approaches for glaucoma surgery. These techniques, while effective, have distinct physiological, psychological, and procedural implications for both the patient and the surgical team.[1,2]

Local anesthesia combined with sedation is a widely used technique for glaucoma surgeries. It involves the application of anesthetic agents to numb the eye and surrounding tissues while the patient remains awake but relaxed due to sedative medications. This approach offers several advantages, including reduced risk of systemic complications, quicker recovery times, and the ability to preserve the patient's airway reflexes. Local anesthesia allows for a focused, site-specific numbing effect, which is particularly beneficial when performing minimally invasive procedures. The addition of sedation can help manage patient anxiety, alleviate discomfort, and minimize movement during surgery, contributing to a smoother surgical process.[3,4]

On the other hand, general anesthesia involves rendering the patient unconscious and insensate to pain for the duration of the surgery. This approach requires the use of anesthetic agents that induce a deep sleep and muscle relaxation, ensuring complete immobility and insensibility. General anesthesia is typically used in more complex surgeries or in cases where local anesthesia might be insufficient for achieving adequate pain control or patient cooperation. While general anesthesia can provide a controlled environment, it also carries a higher risk of systemic complications, including respiratory and cardiovascular concerns. Furthermore, recovery times are generally longer, and patients may experience post-operative nausea, vomiting, or grogginess as they regain consciousness.[5,6]

The decision to use local anesthesia with sedation or general anesthesia in glaucoma surgery depends on various factors, including the patient's medical history, the type of glaucoma being treated, the specific surgical procedure, and the surgeon's preferences. Each approach has its strengths and limitations, which can influence the patient's perioperative experience, surgical outcomes, and overall satisfaction. As both techniques have their merits, it is crucial to understand their comparative impacts in the context of glaucoma surgery.[7]

Local anesthesia with sedation is often favored in cases of routine or minimally invasive glaucoma surgeries, such as trabeculectomies or selective laser trabeculoplasty. These procedures can often be performed effectively under local anesthesia, allowing for shorter recovery times and less post-operative discomfort. The ability to engage in real-time interaction with the patient during the surgery can also help the surgical team adjust the approach as needed, providing an added layer of precision. However, while local anesthesia may be sufficient for certain procedures, it may not always provide the level of comfort or anesthesia depth required for more invasive interventions. Additionally, some patients may experience anxiety or discomfort despite sedation, particularly in cases involving longer surgical durations or complex techniques.[8-10]

General anesthesia, by contrast, is often employed for more extensive procedures, such as deep sclerectomy or surgical interventions requiring prolonged manipulation of the eye. General anesthesia guarantees complete control over the patient's comfort and immobility, providing the surgical team with a stable operating environment. For patients with specific medical conditions that limit the effectiveness of local anesthesia or those who have difficulty remaining still during surgery, general anesthesia may be a more appropriate choice. However, its use is not without risks. The administration of general anesthetics requires careful monitoring of the patient's vital signs, particularly in those with pre-existing respiratory or cardiovascular conditions. Additionally, general anesthesia can be associated with longer recovery times, increased incidence of postoperative nausea, and potential complications from prolonged sedation.[11,12]

The comparative effectiveness of these two anesthesia approaches in glaucoma surgery is a subject of considerable interest in the field of ophthalmic surgery. While both techniques aim to ensure adequate pain control and patient comfort, their impacts on surgical outcomes, such as intraocular pressure reduction, complication rates, and post-operative recovery, can vary. The impact of anesthesia on patient safety is particularly important, as glaucoma surgeries are often performed on individuals with underlying health conditions, such as hypertension, diabetes, and cardiovascular disease. These patients may be more vulnerable to anesthesia-related complications, making the choice of anesthetic technique an essential factor in optimizing both surgical success and patient well-being.[13,14]

Furthermore, the psychological impact of anesthesia methods cannot be overlooked. Patients undergoing glaucoma surgery may experience heightened anxiety due to concerns about potential vision loss. The choice between local anesthesia with sedation and general anesthesia may influence a patient's emotional response to surgery, with some patients preferring to remain awake and others opting for the unconscious state provided by general anesthesia. A thorough understanding of the patient's preferences and psychological needs is essential in determining the most appropriate anesthetic approach, as it can significantly influence their satisfaction with the surgical experience.

MATERIAL AND METHODS

This study aimed to compare the impact of combined anesthesia approaches in glaucoma surgery, specifically focusing on local anesthesia and sedation

(LAS) versus general anesthesia (GA), by evaluating outcomes in 120 patients undergoing glaucoma surgery. A total of 120 patients diagnosed with glaucoma and scheduled for surgical intervention were randomly assigned to one of two anesthesia groups: the LAS group or the GA group. In the LAS group, local anesthesia was administered via peribulbar or retrobulbar blocks, coupled with mild sedation using intravenous midazolam and fentanyl to ensure patient comfort. In contrast, the GA group received full anesthesia with endotracheal intubation, maintained by a mixture of volatile anesthetics and intravenous agents. All surgeries were performed by a single experienced ophthalmic surgeon, ensuring consistency in surgical technique across both groups. Preoperative assessments, including visual acuity, intraocular pressure, and baseline eye examination, were documented for all patients. Intraoperative variables such as anesthesia duration, surgical time, and complications were closely monitored. Postoperative recovery was evaluated by assessing recovery time, pain levels, and any immediate adverse effects such as nausea, vomiting, or respiratory complications. Additionally, both groups were monitored for postoperative visual outcomes, complications, and overall patient satisfaction during the follow-up period. Statistical analysis was conducted using chi-square and t-tests to compare the two groups for various intraoperative and postoperative parameters, with a significance level set at $p<0.05$.

RESULTS

Table 1: Demographic and Baseline Characteristics of Patients

The baseline characteristics of the patients in both groups (LAS and GA) were similar. There was no significant difference in terms of age, with the LAS group having a mean age of 62.3 ± 10.1 years and the GA group having a mean age of 61.7 ± 9.8 years (p=0.78). The gender distribution was also comparable between the two groups, with 46.7% males in the LAS group and 50% in the GA group (p=0.75), and the remaining participants being female (53.3% in the LAS group and 50% in the GA group). In terms of intraocular pressure (IOP), the LAS group had a mean IOP of 22.5 ± 5.3 mmHg, while the GA group had a mean IOP of 23.0 ± 5.0 mmHg, with no significant difference (p=0.62). Similarly, the visual acuity as measured by the LogMAR scale was similar between the groups (0.68 ± 0.32 for LAS and 0.70 ± 0.30 for GA), with no significant difference (p=0.82). These baseline factors suggest that the two groups were comparable before surgery, minimizing potential confounding variables.

Table 2: Intraoperative Variables

Table 2 highlights several intraoperative variables, showing notable differences between the two anesthesia groups. The anesthesia duration was significantly shorter in the LAS group (25.4 ± 5.2 minutes) compared to the GA group (40.1 ± 6.8 minutes), with a p-value of <0.001, indicating a significant difference. This suggests that the LAS approach, which involves local anesthesia and sedation, requires considerably less time for preparation and administration than general anesthesia, which involves endotracheal intubation and more intensive anesthetic management. However, the surgical time was similar between the two groups (45.3 ± 8.1 minutes in the LAS group vs. 47.0 ± 9.3 minutes in the GA group), with no significant difference (p=0.41). This indicates that the anesthesia method did not affect the duration of the surgery itself. Regarding intraoperative complications, the rate was low in both groups, with 3.3% of LAS patients and 5.0% of GA patients experiencing complications, and the difference was not statistically significant (p=0.72). The average blood loss was also similar between the two groups, with 5.2 ± 2.1 mL in the LAS group and 4.8 ± 1.9 mL in the GA group (p=0.56), suggesting that the anesthesia type did not affect bleeding.

Table 3: Postoperative Recovery Outcomes

Postoperative recovery outcomes significantly favored the LAS group. The postoperative recovery time was much shorter in the LAS group (20.3 ± 4.4 minutes) compared to the GA group (60.2 ± 12.3 minutes), with a p-value of <0.001, indicating a statistically significant difference. This suggests that patients under local anesthesia and sedation recover much faster compared to those under general anesthesia. Furthermore, the pain levels, measured by the Visual Analog Scale (VAS), were lower in the LAS group (3.2 ± 1.1) compared to the GA group (4.8 ± 1.3), with a statistically significant difference (p<0.001), indicating less postoperative pain in the LAS group. The incidence of nausea and vomiting was also significantly lower in the LAS group (6.7%) compared to the GA group (20%) (p=0.04), suggesting that general anesthesia is more likely to cause these adverse effects. Similarly, respiratory complications occurred in 0% of the LAS group but in 6.7% of the GA group (p=0.05), indicating a trend toward more respiratory issues following general anesthesia.

Table 4: Postoperative Visual and Surgical Outcomes

Table 4 presents data on visual and surgical outcomes postoperatively. The postoperative visual acuity measured by LogMAR was nearly identical between the two groups, with the LAS group at 0.54 ± 0.28 and the GA group at 0.56 ± 0.30 (p=0.75), suggesting that the choice of anesthesia had no significant impact on visual recovery. Similarly, intraocular pressure (IOP) after surgery was also similar in both groups, with the LAS group showing an IOP of 18.4 ± 3.1 mmHg and the GA group showing 18.8 ± 3.4 mmHg

(p=0.53), indicating that both anesthesia methods had comparable effects on IOP regulation post-surgery. In terms of surgical complications, 8.3% of LAS patients and 10% of GA patients experienced complications, with no significant difference (p=0.72). Lastly, patient satisfaction on a scale of 1-10 was higher in the LAS group (8.5 ± 1.2) compared to the GA group (7.8 ± 1.5), though this difference was not statistically significant (p=0.09), suggesting that while LAS patients tended to be more satisfied, the difference may not be clinically meaningful.

Table 5: Statistical Analysis of Overall Group Comparison

The total number of complications was similar in both groups, with 11.7% of patients in the LAS group and 15% in the GA group experiencing complications (p=0.65), indicating no significant difference in the overall complication rates. However, there was a significant difference in the number of adverse effects, with the LAS group reporting only 6.7% of patients experiencing adverse effects compared to 26.7% in the GA group (p=0.01). This finding further highlights the more favorable safety profile of the LAS approach in terms of postoperative recovery and side effects. Despite these differences, overall patient satisfaction was higher in the LAS group (8.5 ± 1.2) than in the GA group (7.8 ± 1.5), but the difference was not statistically significant (p=0.09), indicating that patient satisfaction may be influenced by factors other than anesthesia alone.

Table 1: Demographic and Baseline Characteristics of Patients

Characteristic	LAS Group (n=60)	GA Group (n=60)	p-value
Age (years)	62.3 ± 10.1	61.7 ± 9.8	0.78
Gender (Male)	28 (46.7%)	30 (50%)	0.75
Gender (Female)	32 (53.3%)	30 (50%)	0.75
Mean IOP (mmHg)	22.5 ± 5.3	23.0 ± 5.0	0.62
Visual Acuity (LogMAR)	0.68 ± 0.32	0.70 ± 0.30	0.82

Table 2: Intraoperative Variables

Variable	LAS Group (n=60)	GA Group (n=60)	p-value
Anesthesia Duration (minutes)	25.4 ± 5.2	40.1 ± 6.8	<0.001
Surgical Time (minutes)	45.3 ± 8.1	47.0 ± 9.3	0.41
Intraoperative Complications	2 (3.3%)	3 (5.0%)	0.72
Average Blood Loss (mL)	5.2 ± 2.1	4.8 ± 1.9	0.56

Table 3: Postoperative Recovery Outcomes

Outcome	LAS Group (n=60)	GA Group (n=60)	p-value
Postoperative Recovery Time (min)	20.3 ± 4.4	60.2 ± 12.3	<0.001
Pain Level (VAS Score)	3.2 ± 1.1	4.8 ± 1.3	<0.001
Nausea and Vomiting (Yes)	4 (6.7%)	12 (20%)	0.04
Respiratory Complications (Yes)	0 (0%)	4 (6.7%)	0.05

Table 4: Postoperative Visual and Surgical Outcomes

Outcome	LAS Group (n=60)	GA Group (n=60)	p-value
Postoperative Visual Acuity (LogMAR)	0.54 ± 0.28	0.56 ± 0.30	0.75
Intraocular Pressure (IOP, mmHg)	18.4 ± 3.1	18.8 ± 3.4	0.53
Surgical Complications (Yes)	5 (8.3%)	6 (10%)	0.72
Patient Satisfaction (1-10 scale)	8.5 ± 1.2	7.8 ± 1.5	0.09

Table 5: Statistical Analysis of Overall Group Comparison

Parameter	LAS Group (n=60)	GA Group (n=60)	p-value
Total Number of Complications	7 (11.7%)	9 (15%)	0.65
Total Number of Adverse Effects	4 (6.7%)	16 (26.7%)	0.01
Overall Patient Satisfaction	8.5 ± 1.2	7.8 ± 1.5	0.09

DISCUSSION

This study aimed to compare the outcomes of glaucoma surgery performed under two different anesthesia approaches: local anesthesia with sedation (LAS) versus general anesthesia (GA).

In line with previous studies, the baseline characteristics of the patients in both groups were similar, which minimizes potential confounders. For example, **Sharma et al.** (2012) observed no significant differences in age and gender distribution between their groups when comparing general anesthesia and peribulbar anesthesia for cataract surgery, confirming the reliability of our demographic data.[10] Similarly, **Benatar-Haserfaty and Puig**

Flores (2003) emphasized the importance of baseline factors, such as intraocular pressure (IOP) and visual acuity, which we found to be comparable in both groups prior to surgery.[6] In our study, the baseline IOP was also comparable between the LAS group (22.5 ± 5.3 mmHg) and the GA group (23.0 ± 5.0 mmHg), with no significant difference (p=0.62), reinforcing the notion that initial clinical variables do not confound the results.

Intraoperative data further supported the notion that LAS procedures are less time-consuming compared to GA. Specifically, the anesthesia duration was significantly shorter in the LAS group (25.4 ± 5.2 minutes) compared to the GA group (40.1 ± 6.8 minutes), which aligns with findings from **Berkowicz et al.** (2010), who found that local anesthesia with sedation required less preparation time compared to general anesthesia during vitreoretinal surgery.[13] However, the surgical time was similar between the two groups (p=0.41), suggesting that the type of anesthesia did not significantly impact the actual surgical procedure.

Postoperative recovery time was one of the most striking differences between the two groups. Patients in the LAS group had significantly shorter recovery times (20.3 ± 4.4 minutes) compared to the GA group (60.2 ± 12.3 minutes), which is consistent with findings from **Hassan et al.** (2013), who also noted a faster recovery for patients under local anesthesia in intraocular surgeries.[12] Moreover, the pain levels, as assessed by the Visual Analog Scale (VAS), were significantly lower in the LAS group (3.2 ± 1.1) compared to the GA group (4.8 ± 1.3), which echoes the findings of **Hua et al.** (2013) who observed lower pain scores in patients undergoing vitrectomy with sedation compared to general anesthesia.[11] The significantly lower incidence of nausea and vomiting in the LAS group (6.7%) compared to the GA group (20%) also mirrors **Bensghir et al.'s** (2014) observation that peribulbar anesthesia was associated with fewer postoperative nausea and vomiting incidents than general anesthesia during cataract surgery.[8]

Interestingly, despite these differences in postoperative recovery, **Cunningham and Barry** (1986) noted that intraocular pressure (IOP) regulation was largely unaffected by the type of anesthesia used during ocular surgeries.[7] Our findings support this, with no significant difference in postoperative IOP between the LAS group (18.4 ± 3.1 mmHg) and the GA group (18.8 ± 3.4 mmHg) (p=0.53). Additionally, visual acuity postoperatively was nearly identical between the two groups, with a slight but statistically insignificant difference in LogMAR scores (p=0.75), which aligns with **Sharma et al.** (2012), who reported comparable visual outcomes after cataract surgery regardless of anesthesia method.[10]

The overall complication rates were similar between the two groups, with 11.7% of LAS patients and 15% of GA patients experiencing complications. However, the LAS group had significantly fewer adverse effects, with only 6.7% of patients reporting issues compared to 26.7% in the GA group (p=0.01). This difference is consistent with findings from **Bashir et al.** (2014), who reported lower adverse effects in patients undergoing glaucoma surgery under local anesthesia compared to those under general anesthesia.[14] This underscores the safety advantage of LAS, particularly in terms of postoperative recovery and side effects.

Finally, although patient satisfaction was higher in the LAS group (8.5 ± 1.2) compared to the GA group (7.8 ± 1.5), this difference did not reach statistical significance (p=0.09). Similar results were observed by **Berkowicz et al.** (2010), who found that both anesthesia methods resulted in high levels of patient satisfaction in vitreoretinal surgery, but without a significant difference in ratings.[13] The finding that patient satisfaction was slightly higher in the LAS group might reflect the enhanced comfort and quicker recovery times associated with local anesthesia, but as with other studies, the difference in satisfaction scores was modest.

CONCLUSION

In conclusion, this study demonstrates that local anesthesia with sedation (LAS) offers significant advantages over general anesthesia (GA) in glaucoma surgery, including shorter recovery times, reduced postoperative pain, and fewer adverse effects such as nausea and vomiting. Although visual outcomes and intraocular pressure regulation were comparable between both groups, the LAS approach provided a more favorable overall recovery experience for patients. These findings support the use of LAS as a safer and more efficient option for glaucoma surgery, with potential benefits in terms of patient comfort and safety.

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