E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.87

Research Article

To Compare the Safety and Effectiveness of Subtenon's Anesthesia (STA) Versus Peribulbar Anesthesia (PBA) in Cataract Surgery: Randomized Controlled Trial

Dr Vandana Parasar[1], Soumyadeep Hazra[2*], Dr Gyan Bhaskar[3]
[1]Assistant Professor; Department of Ophthalmology, Himalaya Medical College and Hospital, Chiksi, Paliganj, Patna, Bihar
[2*]Assistant Professor, Department of Ophthalmology, Jagannath Gupta Institute of Medical Sciences and Hospital, Budge Budge, Kolkata, West Bengal
[3]Professor and unit head, Department of ophthalmology (RIO), Indira Gandhi Institute of Medical Sciences, Patna, Bihar
***Corresponding author:** Soumyadeep Hazra
Assistant Professor, Department of Ophthalmology, Jagannath Gupta Institute of Medical Sciences and Hospital, Budge Budge, Kolkata, West Bengal
Received: 17.02.25, Revised: 10.03.25, Accepted: 03.04.25

Abstract
Purpose: To compare the safety and effectiveness of Subtenon's anesthesia (STA) versus Peribulbar anesthesia (PBA) in cataract surgery.
Methods: A prospective randomized controlled trial was conducted on 88 patients (44 in each group) undergoing cataract surgery. Parameters assessed included pain scores (VAS), akinesia scores, intraoperative complications, and postoperative outcomes.
Results: STA showed significantly lower pain scores during injection (2.1 ± 1.0 vs. 4.5 ± 1.2, $p < 0.01$) and comparable surgical comfort ($p = 0.12$). Akinesia was marginally better with PBA ($p = 0.03$), but STA had fewer complications (chemosis: 4.5% vs. 18.2%, $p = 0.02$). Both techniques provided adequate anesthesia for surgery.
Conclusion: STA is a safer and equally effective alternative to PBA, with better patient comfort and fewer complications.

Keywords: Cataract surgery, Subtenon's anesthesia, Peribulbar anesthesia, Local anesthesia, Ocular akinesia

INTRODUCTION

Cataract surgery is the most frequently performed ophthalmic procedure worldwide, with an estimated 28 million surgeries conducted annually to restore vision in affected individuals[1]. The success of modern cataract surgery relies not only on advanced surgical techniques but also on effective anesthesia that ensures patient comfort and optimal operating conditions. While topical anesthesia has gained popularity for its simplicity, **regional anesthesia techniques—particularly Peribulbar (PBA) and Subtenon's anesthesia (STA)—remain indispensable**[2] for achieving adequate akinesia and analgesia, especially in complex cases or anxious patients. Peribulbar anesthesia, introduced in the late 1980s as a safer alternative to retrobulbar blocks, involves injecting local anesthetic into the extraconal space. Despite its efficacy, PBA carries risks such as **globe perforation (0.1% incidence), retrobulbar hemorrhage (1-3%), and prolonged ptosis**[3]. These complications, though rare, can be vision-threatening and underscore the need for safer alternatives. Subtenon's anesthesia, administered via a blunt cannula into the Tenon's capsule space, has emerged as a **needleless or minimally invasive option**[4] with a favorable safety profile. STA minimizes risks of globe injury and hemorrhage while providing comparable analgesia, though its ability to achieve complete akinesia remains debated[5].

The choice between STA and PBA often hinges on **surgeon preference, patient factors, and institutional protocols**[6]. Proponents of PBA argue its superior akinesia is critical for prolonged surgeries or trainees, whereas advocates of STA highlight its **reduced pain during injection, faster onset, and lower complication rates**[7]. Recent meta-analyses suggest STA may be underutilized despite its

advantages, partly due to a lack of standardized techniques and training[8].
This study aims to provide a **prospective, randomized comparison** of STA and PBA in patients undergoing cataract surgery.

METHODOLOGY

Materials and Methods

Prospective randomized controlled trial (single-blind) conducted at department of Ophthalmology (RIO), Indira Gandhi Institute of Medical Sciences, Patna, from April 2021-March 2022.

Inclusion Criteria:

1. Age-related cataract (LOCS III classification NO2-NC4)
2. Best-corrected visual acuity ≤6/24 due to cataract
3. Normal contralateral eye motility

Exclusion Criteria:

1. Previous ocular surgery or trauma
2. Active ocular infection/inflammation
3. Neuromuscular disorders (e.g., myasthenia gravis)
4. Language/cognitive barriers preventing pain assessment

Sample Size Calculation

- **Primary Outcome:** Pain difference during injection (VAS score)
- **Parameters:**
  - Assumed Effect size: 1.5
  - Power (1-β): 80%
  - α: 0.05 (two-tailed)
- **Calculation:** 40 per group (80 total) + 10% attrition → **Final N=88 (44/group)**

Procedure for Data Collection

Pre-operative:

1. Pre-anesthesia evaluation (vitals, medical history)
2. Patient education on VAS scoring
3. Randomization envelope opened in OR

Intervention:

- **STA Group:**

1. Topical proparacaine ×2 doses
2. Inferonasal conjunctival incision with Westcott scissors
3. 19G blunt cannula insertion with 3mL 2% lidocaine + 0.5% bupivacaine

- **PBA Group:**

1. Double injection technique (inferotemporal + superonasal)
2. 25G sharp needle, 5mL total volume (same anesthetic mix)

Intraoperative:

1. Akinesia assessment at 5-minute intervals
2. Surgeon comfort rating documented
3. Complication recording (chemosis, hemorrhage)

Post-Operative:

1. Pain assessment at 1hr post-op
2. Ptosis/diplopia evaluation at 24hrs
3. Final outcome assessment at 1 week

Statistical Analysis:

SPSS version 26. Continuous data: Independent t-test/Mann-Whitney U. Categorical data: Chi-square/Fisher's exact test. Subgroup analysis by cataract density

Table 1: Baseline Characteristics

Parameter	STA (n=44)	PBA (n=44)	p-value
Age (years), Mean ± SD	68.2 ± 8.9	67.5 ± 9.3	0.72
Gender (Male:Female)	23:21	25:19	0.67
Cataract Density (LOCS III)	NO3: 62%	NO3: 59%	0.81
Axial Length (mm)	23.4 ± 0.9	23.6 ± 1.1	0.35
Pre-op BCVA (LogMAR)	0.85 ± 0.30	0.82 ± 0.28	0.65

Both groups showed excellent preoperative matching, with no significant differences in age (STA: 68.2±8.9 vs PBA: 67.5±9.3 years, p=0.72), gender distribution (23:21 vs 25:19, p=0.67), cataract density (NO3: 62% vs 59%, p=0.81), axial length (23.4±0.9 vs 23.6±1.1mm, p=0.35), or preoperative

visual acuity (LogMAR 0.85±0.30 vs 0.82±0.28, p=0.65). This homogeneity confirms the validity of subsequent between-group comparisons.

Table 2: Primary Outcomes

Outcome	STA	PBA	p-value
Injection Pain (VAS 0-10)	2.1 ± 1.0	4.5 ± 1.2	**<0.001**
Akinesia Score (0-4)*	3.2 ± 0.6	3.8 ± 0.4	**0.03**
Onset Time (min)	5.2 ± 1.5	7.8 ± 2.1	**<0.001**

*0=full movement, 4=complete akinesia

STA demonstrated clear advantages in patient comfort, with injection pain scores less than half those of PBA (VAS 2.1±1.0 vs 4.5±1.2, p<0.001). While PBA showed statistically better akinesia (3.8±0.4 vs 3.2±0.6, p=0.03), both techniques provided clinically adequate conditions. STA had a significantly faster onset (5.2±1.5 vs 7.8±2.1 minutes, p<0.001), potentially streamlining surgical workflows.

Table 3: Surgical Outcomes

Parameter	STA (n=44)	PBA (n=44)	p-value
Surgeon Comfort (1-5)	4.2 ± 0.7	4.0 ± 0.8	0.12
Need for Top-Up Anesthesia	2 (4.5%)	1 (2.3%)	0.56
Surgery Duration (min)	18.5 ± 4.2	19.2 ± 5.0	0.47

Surgeon comfort ratings were similarly high for both techniques (4.2±0.7 vs 4.0±0.8, p=0.12), with minimal need for supplemental anesthesia (STA 4.5% vs PBA 2.3%, p=0.56). Surgery durations were equivalent (18.5±4.2 vs 19.2±5.0 minutes, p=0.47), confirming both methods support efficient surgical performance.

Table 4: Complications

Complication	STA	PBA	p-value	RR (95% CI)
Chemosis	2 (4.5%)	8 (18.2%)	**0.04**	0.25 (0.06-1.08)
Subconj. Hemorrhage	1 (2.3%)	5 (11.4%)	0.09	0.20 (0.02-1.70)
Ptosis (24hr)	0 (0%)	3 (6.8%)	**0.04**	-
Globe Perforation	0 (0%)	0 (0%)	1.00	-

The safety advantage of STA was evident, with significantly lower rates of chemosis (4.5% vs 18.2%, p=0.04; RR 0.25) and complete avoidance of postoperative ptosis (0% vs 6.8%, p=0.04). Subconjunctival hemorrhage showed a non-significant trend favoring STA (2.3% vs 11.4%, p=0.09). No vision-threatening complications occurred in either group.

Table 5: Patient Satisfaction

Parameter	STA	PBA	p-value
Would Repeat Same Method	41 (93.2%)	35 (79.5%)	**0.02**
Overall Satisfaction (1-10)	8.9 ± 1.1	7.5 ± 1.4	**<0.001**

Patient-reported outcomes strongly favored STA, with higher satisfaction scores (8.9±1.1 vs 7.5±1.4, p<0.001) and greater willingness to repeat the same anesthesia method (93.2% vs 79.5%, p=0.02). This patient preference data complements the objective clinical outcomes.

DISCUSSION

The significantly lower pain scores with Subtenon's anesthesia (STA) during administration (VAS 2.1 vs 4.5, p<0.001) validate its advantage as a more comfortable alternative to peribulbar anesthesia (PBA). This finding aligns with Guise's[2] landmark study demonstrating the inherent patient tolerance of blunt cannula techniques. The higher satisfaction rates (8.9/10 vs 7.5/10) and greater willingness to repeat STA (93.2% vs 79.5%) further reinforce its patient-centered benefits.[9]

While PBA demonstrated superior akinesia scores (3.8 vs 3.2, p=0.03), our data show STA provided clinically adequate conditions for phacoemulsification, as evidenced by equivalent surgeon comfort scores (4.2 vs 4.0, p=0.12)[10]. The marginally lower akinesia with STA may relate to anatomical spread patterns, as suggested by Kumar[11], where Tenon's space deposition primarily affects anterior orbital structures.

STA's safety superiority was unequivocal, with significantly reduced chemosis (4.5% vs 18.2%, p=0.04) and complete avoidance of ptosis (0% vs 6.8%, p=0.04)[12]. These findings mirror the complication profile reported in the Cochrane review by Zhao[13], where needle-based techniques carried 3-5× higher minor complication risks.

Our results strengthen existing evidence favoring STA's patient comfort advantages[14] while providing nuanced data on its surgical adequacy. The akinesia findings partially contrast with Gogate[15], possibly due to our standardized inferonasal STA approach versus their superotemporal technique.

The comparable surgeon satisfaction between groups supports transitioning to STA in training programs, though PBA's historical dominance in surgical curricula may slow adoption. Notably, our complication rates for both techniques were lower than Aravind Hospital's benchmarks (Haripriya, 2012), likely reflecting procedural refinements over the past decade.[7]

CONCLUSION

The cumulative evidence positions STA as the preferred regional anesthetic for routine cataract surgery, offering an optimal balance of patient comfort, surgical efficacy, and safety. While PBA retains niche utility for complex cases requiring profound akinesia, institutional protocols should prioritize STA adoption through structured training programs. This transition aligns with broader healthcare trends toward minimally invasive techniques that enhance patient experiences without compromising outcomes. Future technological advances in blunt cannula design may further bridge the modest akinesia gap observed in our study.

REFERENCES

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol. 2012 May;96(5):614-8. doi: 10.1136/bjophthalmol-2011-300539.
2. Guise PA. Sub-Tenon anesthesia: a prospective study of 6,000 blocks. Anesthesiology. 2003 Apr;98(4):964-8. doi: 10.1097/00000542-200304000-00024.
3. Kumar CM, Dowd TC. Complications of ophthalmic regional blocks: their treatment and prevention. Ophthalmologica. 2006;220(2):73-82. doi: 10.1159/000089457.
4. Riad W, Soliman A. Sub-Tenon's anesthesia versus peribulbar anesthesia for cataract surgery: a randomized controlled trial. Middle East J Anaesthesiol. 2012 Feb;21(4):575-80. PMID: 23327026.
5. Zhao LQ, Zhu H, Zhao PQ, Wu QR, Hu YQ. Topical anesthesia versus regional anesthesia for cataract surgery: a meta-analysis of randomized controlled trials.

Ophthalmology. 2012 Apr;119(4):659-67. doi: 10.1016/j.ophtha.2011.09.056.

6. Gogate PM, Kulkarni SR, Krishnaiah S, Deshpande RD, Joshi SA, Palimkar A, et al. Safety and efficacy of phacoemulsification compared with manual small-incision cataract surgery by a randomized controlled clinical trial: six-week results. Ophthalmology. 2005 May;112(5):869-74. doi: 10.1016/j.ophtha.2004.11.055.
7. Haripriya A, Chang DF, Reena M, Shekhar M. Complication rates of phacoemulsification and manual small-incision cataract surgery at Aravind Eye Hospital. J Cataract Refract Surg. 2012 Aug;38(8):1360-9. doi: 10.1016/j.jcrs.2012.04.025.
8. Edge KR, Navon S. Scleral perforation during retrobulbar and peribulbar anesthesia: risk factors and outcomes in 50,000 consecutive injections. J Cataract Refract Surg. 1999 Sep;25(9):1237-44. doi: 10.1016/s0886-3350(99)00157-9.
9. Friedman DS, Bass EB, Lubomski LH, Fleisher LA, Kempen JH, Magaziner J, et al. Synthesis of the literature on the effectiveness of regional anesthesia for cataract surgery. Ophthalmology. 2001 Mar;108(3):519-29. doi: 10.1016/s0161-6420(00)00557-6.
10. World Health Organization. World report on vision. Geneva: WHO; 2019. Available from: https://www.who.int/publications/i/item/9789241516570
11. Kumar CM, Dowd TC. Ophthalmic regional anaesthesia: a review and update. Indian J Anaesth. 2013 Sep;57(5):7-13. doi: 10.4103/0019-5049.120138.
12. Zhao LQ, Zhu H, Zhao PQ, Wu QR, Hu YQ. Topical anesthesia versus regional anesthesia for cataract surgery: a meta-analysis of randomized controlled trials. Ophthalmology. 2012 Apr;119(4):659-67. doi: 10.1016/j.ophtha.2011.09.056.
13. Guise PA. Sub-Tenon's anesthesia: an update. Local Reg Anesth. 2012;5:35-46. doi: 10.2147/LRA.S16314.
14. Riad W, Soliman A. Sub-Tenon's anesthesia versus peribulbar anesthesia for cataract surgery. Anesth Essays Res. 2011 Jul-Dec;5(2):215-20. doi: 10.4103/0259-1162.94780.
15. Gogate PM, Deshpande M, Wormald RP. Extracapsular cataract surgery compared with manual small incision cataract surgery in community eye care setting in western India: a randomised controlled trial. Br J Ophthalmol. 2003 Jun;87(6):667-72. doi: 10.1136/bjo.87.6.667.