Comparison between subtenon block and extraconal block during cataract surgery

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Background Most ophthalmic procedures are performed under local anesthesia, and cataract extraction is the most frequently performed surgery in elderly patients. The aim of this study is to compare the intraoperative hemodynamic variables, efficacy, and efficiency of extraconal block versus subtenon block with low concentration of local anesthetic during cataract surgery.

Patients and methods This prospective, randomized, and single-blind study was done on 80 patients American Society of anesthesiologists status I–III undergoing cataract surgery, of which 40 patients underwent subtenon block (group S) and 40 patients underwent extraconal block (group E). Five minutes after the start of anesthetic monitoring care, 5-ml mixture of lidocaine 1% and bupivacaine 0.25% containing 100 IU hyalorunidase, in a mixture ratio of 1 : 1, was injected intraocular slowly. Patients were monitored for intraoperative hemodynamics, ocular movement during surgery, and intraoperative pain sensation as primary outcome, and onset of blockade, pain assessment within 30 min postoperatively, number of patients need rescue dose, surgeon discomfort, and postoperative complications as secondary outcomes.

Results Mean arterial blood pressure and heart rate in group S were significantly lower than those in group E but within safety margin. No significant difference was found between the two groups regarding full range of eye movement, surgeon's discomfort grade during cataract surgery, and also, intraoperative pain sensation. The onset of blockade was significantly faster in group S than group E. Although group S had better postoperative analgesic effect than group E, postoperative rescue dose was of insignificant value.

Conclusion Subtenon block seems to be a better local anesthetic technique than extraconal for cataract surgery, as it is faster, has less surgeon discomfort grading, and better postoperative analgesia. However, on the contrary, both subtenon and extraconal blocks are equally effective in pain control during surgery and also have good ocular akinesia during operation.

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Introduction

Regional nerve block is the technique of choice for cataract surgery in many hospitals, because cataract surgery is the most common outpatient operation and can be safely performed with this technique [1,2].

The terminology used for regional ophthalmic block is controversial; the name based on anatomical placement of the needle is accepted widely [3]. An intraconal (retrobulbar) block involves the injection of a local anesthetic agent into the orbital cavity (muscle cone), behind the globe formed by four recti muscles and the superior and inferior oblique muscles [4]. Although extraconal (peribulbar) block introduced in 1986 is a safer alternative to retrobulbar block, the needle tip remains outside the muscle cone [5]. Multiple communications exist between retrobulbar and peribulbar techniques, and it is difficult to differentiate whether the needle is intraconal or extraconal after placement [6]. Computerized tomography studies after intraconal and extraconal injections of radiocontrast material have demonstrated the existence of multiple communications between these two compartments, with the injected material diffusing between the compartments [7]. Injected local anesthetic agent diffuses, and depending on its spread, anesthesia and akinesia may occur [7]. It is appropriate to assume in clinical settings that if there is a rapid onset of akinesia, the needle tip or injected local anesthetic agent has diffused in the intraconal area [8]. If akinesia, however, is slow in onset and not complete, the needle or local anesthetic agent has not reached the intraconal area in a sufficient amount and the block is extraconal [9]. According to a recent report by Cataract National Dataset Electronic Multicentre Audit of 55 567 operations, local anesthesia was used in 95.5%, with topical anesthesia alone in 22.3%, topical and intracameral in 4.7%, subtenon in 46.9%, peribulbar

in 19.5% and retrobulbar in 0.5% [10]. Nowadays, regional ocular block has become a common technique in many countries, whereas subtenon block is established in only a few centers [4]. Complications of these blocks range from mild to serious and have been reported and published in many reviews. The complications may be limited to the orbit or may be systemic. Orbital complications include failure of the block, corneal abrasion, chemosis, conjunctival hemorrhage, vessel damage leading to retrobulbar hemorrhage, globe perforation, globe penetration, optic nerve damage, and extraocular muscle damage. Systemic complications, such as local anesthetic agent toxicity, brain stem anesthesia, and cardiorespiratory arrest may be due to accidental intravenous injection and spread or misplacement of drug in the orbit during or immediately after injection [11].

Most surgeons and anesthetists have been interested in subtenon technique since 1984, as the tenon's capsule is a thin layer of connective tissue that surrounds the globe [12]. Anteriorly, it lies in close position to the conjunctiva and fuse with it at the level of the limbus; it extends posteriorly in all direction around the globe, ultimately fusing with the dura of the optic nerve, an interval along its course it pierced by the extraocular muscle as they insert into the globe [2]. Local anesthetic is injected around the globe during subtenon block and injected into the extraconal space during extraconal block [13]. Several studies have compared regional nerve block, that is, subtenon block versus extraconal block [14]. It has been suggested that the subtenon technique has a more acceptable risk profile than extraconal technique, and it is a safer and more efficient technique for local anesthesia [15]. In comparison with general anesthesia, regional anesthesia decreases postoperative pain, vomiting, and the incidence of oculocardiac reflex in cataract surgery [16].

This study was performed to compare regional anesthesia, subtenon versus extraconal block with regard to onset of blockade, analgesic effect, surgeon's comfort, and postoperative complications.

Patients and methods

This prospective, randomized, and single-blind study was approved by the Clinical Research Ethics Committee of Anesthesia and Intensive Care Department, Faculty of Medicine, Al-Azhar University, Egypt. The study was performed in the operation theater of Bab-Elshereia university hospital, Al-Azhar University, Cairo, Egypt. Patient enrollment started in August 2014 and ended in September 2016. A total of 80 patients with American Society of Anesthesiologists status I, II, and III, aged between 55 and 75 years scheduled for elective uncomplicated cataract surgery under local anesthesia were recruited. Written informed consent was obtained from each patient after a detailed explanation about the conduction of the study. Selected cases were categorized into two groups, each with 40 patients: group S (subtenon) and group E (extraconal). Exclusion criteria included patients younger than 55 or older than 75 years; patient refusal to participate; known sensitivity to local anesthetics; history of convulsion or epilepsy; previous intraocular injury, inflammation, or surgery; pupil less than 5 mm in diameter; inability to understand the visual analog pain scale; and patients with mental disability, coagulopathy, and end-stage organ disease (e.g. renal disease on dialysis). No premedications were prescribed in any patient. On arrival to the operation room, standard monitoring were set as noninvasive blood pressure, ECG, and pulse oximetry, and an intravenous cannula was placed. Initial globe movements in all directions of gaze (superior, inferior, medial, and lateral) were assessed. Oxygen nasal cannula is put to deliver 4 l/min oxygen, and 0.01 mg/kg atropine sulfate was given intravenously to prevent oculocardiac reflex. Local anesthetic was prepared as 1 : 1 mixture of lidocaine 1% and bupivacaine 0.25% containing hyalorunidase 20 unit/ml, and then extraconal block was performed with blunt-tipped 25-G 30-mm short bevel needle. The block was performed while the patient is in supine position and looking directly ahead; insertion of the needle was through the lower eyelid as far lateral as possible in the inferotemporal quadrant. After negative aspiration, a volume of 8–10 ml of local anesthetic solution was injected. Digital pressure was applied by the thumb and index fingers around the needle hub during injection; the injection was discontinued when lid fullness appeared. Compression was applied for 3–5 min to help distribution of anesthetic agent and reduce the intraocular pressure. For subtenon block, the conjunctiva would first need to be anesthetized with topical anesthetic solution, such as amethocaine and proxymetacaine 5% drops. The anesthetized conjunctiva should be cleaned carefully by putting a few drops of povidone iodine under the lower eyelid. An eyelid speculum is inserted to improve access and prevent from blinking. Asking the patient to look up and laterally will assist in exposing the inferonasal quadrant. A small incision is made in the conjunctiva and tenon's capsule ~5–10 mm from the inferonasal limbus using a pair of ophthalmic scissors special curved blunt metal cannula gauze 19–25 mm is designed for this purpose, is introduced along the contour of the globe until it lies in the posterior segment. Slow delivery of 5 ml of local anesthetic

prepared was injected in the inferomedial quadrant of the eye. Hyaluronidase is used in both techniques to help spreading of the drugs without increasing the volume. Heart rate, mean arterial blood pressure, respiratory rate, and O_2 saturation (SPO_2) were recorded during the surgery starting after 5 min after anesthesia and then every 15 min till end of surgery, which was 60 min (time of study). In both techniques, pain and motility were assessed. Assessment of pain was done every 5 min after local anesthesia injection by numerical pain reporting scale [17]. Patients were asked to grade the pain they felt on a linear scale of 0–4 (no pain=grade 0, mild pain=grade 1, moderate pain=grade 2, severe pain=grade 3, and maximum pain imaginable=grade 4). The postoperative pain was assessed immediately after surgery in postanesthetic care unit (PACU) and at 30 min postoperatively using the same scale. Rescue dose (50 mg pethidine) was given intravenously for pain management if needed, and total doses were recorded. Assessment of motility and measurement of ocular movement in all four quadrants (inferior, superior, medial, and lateral) were done by an independent assessor who was not aware of the anesthetic technique used; the reference point was the limbus of the appropriate quadrant. The patient was instructed to look in the primary position of gaze where possible. The zero mark of the rule was aligned with the limbus of the appropriate quadrant, and the patient was instructed to look toward that quadrant, and the extent of limbal excursion in that direction read off from the rule. Excursion was scored in the range from 0 (no movement) to 8 (complete movement) and was categorized into three groups: akinesia (score 0–4), mild movement (4–6), and no akinesia (score 6–8). The motility was assessed every 2 min until akinesia was attained or up to 10 min after the injection of anesthesia. If akinesia was not achieved at 10 min, supplemental injection was given. Ophthalmologists also graded the 'discomfort' they felt during surgery (grade 0=no discomfort, grade 1=mild discomfort, grade 2=moderate, grade 3=severe, and grade 4=surgery not possible).

Table 1 Demographic and preoperative characteristics of patient groups

Variables	Group S (n=40) (mean±SD)	Group E (n=40) (mean±SD)	P value
Age (years)	65±7.3	68±4.6	0.72
Weight (kg)	68±3.49	70±2.32	0.51
Height (cm)	167±2	165±4	0.67
Sex (female/male)	16/24	19/21	0.31
Surgical time (min)	45.68±12.01	47.28±12.06	0.74

E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

Statistical analysis

Data were collected, tabulated, coded, and then analyzed using SPSS computer software, version 15 (SPSS Inc., Chicago, Illinois, USA). First, numerical variables were examined for normality and then were presented as mean ±SD or median (interquartile range) whenever appropriate. On the contrary, categorical variables were presented as number of cases (percent). Unpaired Student's *t*-test was used for between-group comparison of numerical variables if they showed normal distribution, otherwise Mann–Whitney test was used, which was also applied for comparison between maximum sensory blockade levels among the two groups. χ^2-Test or Fisher's exact test was used, whenever appropriate, for comparison between groups with regard to categorical variables. A difference with '*P*' value less than or equal to 0.05 was considered statistically significant; a difference with '*P*' value less than or equal to 0.01 was considered moderately significant, and a difference with '*P*' value less than or equal to 0.001 was considered highly significant; otherwise, it was insignificant.

Results

Patient characteristics and demographic data are presented in Table 1. There were no significant differences between the two groups in terms of age, weight, height, sex, and operation time. After regional nerve block with local anesthetics injection, heart rate, and mean arterial blood pressure were statistically insignificant in both groups at baseline, and fifth min ($P>0.05$), whereas starting from 15 min from beginning of the study, they were significantly lower in group S than those in group E (within safety margin; $P<0.05$; Tables 2 and 3).

Table 2 Changes in heart rate (beats/min)

	Group S (n=40) (mean ±SD)	Group E (n=40) (mean±SD)	P value
HR 0	87.15±3.64	86.24±4.15	0.380
HR 5	84.40±2.72	85.93±3.75	0.097
HR 15	78.55±4.55	96.85±3.09	0.025
HR 30	79.04±3.64	93.74±3.14	0.037
HR 45	83.95±2.09	94.62±2.72	0.043
HR 60	81.52±3.93	96.04±2.89	0.018

Baseline=0. E, extraconal block group; HR, heart rate; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

Table 3 Changes in mean arterial blood pressure (mmHg)

	Group S (*n*=40) (mean ±SD)	Group E (*n*=40) (mean±SD)	*P* value
0 min	105.41±7.22	107.16±9.13	0.412
5 min	100.12±6.13	103.13±7.32	0.265
15 min	97.13±3.25	117.54±4.13	0.021
30 min	100.12±5.13	113.22±5.22	0.036
45 min	99.14±2.25	113.31±5.12	0.019
60 min	103.12±5.27	116.87±7.26	0.027

Baseline=0. E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

Table 4 Intraoperative pain assessment by numerical rating pain scale

	Grade 0 (no pain)	Grade 1 (mild pain)	Grade 2 (moderate pain)	Grade 3 (severe pain)	Grade 4 (maximum imaginable pain)
Group S (*n*=40) [*n* (%)]	29 (72)	8 (20)	2 (5)	1 (2.5)	0 (0.0)
Group E (*n*=40) [*n* (%)]	26 (70)	8 (20)	4 (10)	2 (5)	0 (0)
t-Test					
t	0.542	1.432	0.432	0.543	>0.05
P	0.603	0.327	0.765	0.580	>0.05

E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

However, there were no significant differences between both groups in terms of respiratory rate and O_2 saturation (SPO_2) recorded. With regard to intraoperative pain sensation assessed by NRS, 29 (72%) patients in group S versus 26 (70%) in group E reported grade 0 (no pain), with *P* value of 0.603; eight (20%) patients in group S versus eight (20%) in group E reported grade 1 (mild pain), with *P* value of 0.765; two (5%) patients in group S versus four (10%) patients in group E reported grade 2 (moderate pain), with *P* value of 0.580; only one (2.5%) patient in group S versus two (5%) in group E reported grade 3 (severe pain) (50 mg pethidine was given and operation was continued; there was insignificantly difference between the two groups, with *P*=0.580), and no patient in both groups developed grade 4 (max imaginable pain; Table 4).

With regard to intraoperative eye movement, 34 (85%) patients in group S compared with 31 (77%) patients in group E had no eye movement, four (10%) patients in group S compared with six (15%) patients in group E had mild eye movement, and two (5%) patients in group S compared with three (7%) patients in group E had moderate eye movement but not preventing surgery, with *P* value of 0.621 (Table 5).

Table 5 Intraoperative eye movement degree

	No movement [*n* (%)]	Mild movement [*n* (%)]	Moderate movement [*n* (%)]
Group S (*n*=40)	34 (85)	4 (10)	2 (5)
Group E (*n*=40)	31 (77)	6 (15)	3 (7)
Total (*N*=80)	65	10	5
χ^2			
χ^2		0.790	
P		0.621	

E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

Table 6 Time of onset of blockade

Variables	Group S (*n*=40)	Group E (*n*=40)	*P* value
Time to onset of blockage (min)	6.5±1.60	8.3±1.42	0.022

E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

Table 7 Postoperative patients' number needed rescue dose

	PACU [*n* (%)]	30 min postoperative [*n* (%)]	χ^2	
			χ^2	*P* value
Group S (*n*=40)	1 (2.5)	4 (10)		
Group E (*n*=40)	1 (2.5)	5 (12.5)	0.293 0.168	0.469
Total (*N*=80)	2 (5)	9 (22.5)		

E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; PACU, postanesthetic care unit; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

With regard to the onset of blockage, it was statistically significant shorter in group S (6.5±1.16 min) in comparison with group E (8.3±1.42 min, *P*=0.022; Table 6).

For postoperative rescue dose needed (50 mg pethidine) in PACU, only one patient in both groups needed it, whereas at 30 min postoperatively in PACU, four (10%) patients in group S compared with five (12.5%) patients in group E needed it (*P*=0.469; Table 7).

Table 8 Surgeon discomfort grading

	Group S (*n*=40) [*n* (%)]	Group E (*n*=40) [*n* (%)]	*P* value
Grade 0	31 (77)	29 (72)	0.436
Grade 1	7 (17)	7 (17)	0.527
Grade 2	2 (5)	4 (10)	0.113
Grade 3	0 (0)	0 (0)	>0.05
Grade 4	0 (0)	0 (0)	>0.05

Grade 0=no discomfort, grade 1=mild discomfort, grade 2=moderate, grade 3=severe, and grade 4=surgery not possible. E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

With regard to surgeon's discomfort grading, it was grade 0 for 31 (77%) surgeons in group S versus 29 (72%) surgeons in group E, with *P* value of 0.436; for grade 1, seven (17%) surgeons each complained in both groups, with *P* value of 0.527; for grade 2, two (5%) surgeons in group S versus four (10%) surgeons in group E, with *P* value of 0.113); and for grade 3 and grade 4, no surgeon complaint was recorded (Table 8).

For postoperative complications including failure of block, PONV, or unplanned hospital admission, there were a statistically insignificant difference ($P>0.05$; Table 9).

Table 9 Postoperative complication

Variables	Group S (*n*=40)	Group E (*n*=40)	*P* value
Failure of block	0	0	>0.05
PONV	0	0	>0.05
Unplanned hospital admission	0	0	>0.05

E, extraconal block group; *P*, Student's independent sample *t*-test values for comparison between the two groups; PONV, postoperative nausea and vomiting; S, subtenon block group. $P>0.05$, insignificant; $P\leq0.05$, significant.

Discussion

In this randomized, single-blind study, the effect of subtenon block versus extraconal block was compared in terms of hemodynamic variables, ocular movement during surgery, pain perception during surgery, onset of blockade, surgeon's comfort grading, rescue dose, and postoperative complications. The extraconal block is the most common used in most instances, but subtenon technique has more popularity, as it is safe, faster, more efficient, and does not require sharp needle [18]. Cataract surgery is the commonest outpatient ophthalmic procedure, and regional anesthesia is usually preferred than general anesthesia [19]. In this current study, there was better akinesia in subtenon group when compared with extraconal group, but with no statistical significant difference. This comes in agreement with the study done by Kapran *et al.* [20], as they found that subtenon block achieved better akinesia than extraconal block, but the results were statistically insignificant. With regard to hemodynamics, heart rate and mean arterial blood pressure increased within safety margin (within 20% from baseline) in patients who received extraconal block more than patients who received subtenon block, which might be explained by the endocrinal response triggered by extraconal blockade, as this approach was a more painful technique than subtenon blockade as injection is done in narrower space under tension. Moreover, regarding intraoperative pain sensation, it was found to be lower in subtenon group than extraconal one, but was statistically insignificant. This result comes in agreement with the work done by Davis *et al.* [6], which evaluated different local anesthetic techniques of subtenon versus peribulbar anesthesia for cataract surgery in the UK. They demonstrated that subtenon technique was more effective than the peribulbar technique, with significantly fewer patients experiencing unacceptable levels of pain. It was significantly less uncomfortable on administration than the peribulbar methods and reduced the time interval between administration of anesthesia and surgery. On the range of 1–10, pain on administration of anesthetic had a mean of 2.4 for the peribulbar group and 1.4 for the subtenon group. The onset of blockade was significantly faster in subtenon group than in extraconal group, which is owing to the spread of local anesthetic through subtenon capsule, which had increased development of sensory block. Moreover, we are in agreement with the study done by Gogate *et al.* [21] and Parkar e*t al.* [22] who studied extracapsular cataract surgery compared with manual small incision cataract surgery and found that subtenon anesthesia was found to be more comfortable for the patient, was reliable, was long lasting, and with deeper anesthesia as compared with topical anesthesia for phacoemulsification patients. However, our results are not in agreement with the study done by Jacobi *et al.* [13], which found that regarding intraoperative pain assessment using visual analog scale during cataract extraction, there were highly significant lower pain scores for subtenon group compared with extraconal one, and also, there were significant differences between the two groups in terms of rescue dose at first and second hours, postoperatively. These differences in results may be explained by the different methodology, as in the current study, pain was assessed using numerical rating pain scale, and also, time was limited to only 30 min postoperatively to assess pain.

With regard to surgeon's satisfaction, subtenon was better than extraconal blockade, but was statistically insignificant. Moreover, with regard to postoperative complication, there were no statistically significant differences between the two groups. This study is in agreement with that done by Rizzuto *et al.* [19] who studied subtenon's local anesthesia for optic nerve sheath fenestration and found that subtenon anesthesia has also been used for optic nerve sheath fenestration. It was also more comfortable for the surgeon, that is, subtenon block was more pain free with better pupillary dilatation. They recommended that subtenon technique appeared to be the safest method of introducing anesthetic fluid into the retrobulbar space without the potential complication. The current study correlated with the study done by Zafirakis *et al.* [23], who found that subtenon anesthesia offers a significantly reduced risk of complication such as scleral perforation, retrobulbar hemorrhage, optic nerve injury, and injection of anesthetic solution into the subarachnoid space, as no sharp instrument is passed into the orbit. It should, however, be used with caution in patients with compromised sclera, as a single case of globe perforation was reported in a patient who underwent detachment surgery and had thinned sclera. Moreover, for phacoemulsification, it was found that retrobulbar techniques had less discomfort/pain during surgery.

Conclusion

Although there is a lack of published data worldwide on the use of local anesthetic technique, it appears that regional ocular block has become the commonest technique in many countries. The present study indicates that patients who undergo subtenon blockade technique had faster onset blockade, less surgeon discomfort grading, and better both intraoperative and postoperative analgesic effect when compared with extraconal blockade technique. Both subtenon and extraconal blockades are equally effective techniques in providing sufficient ocular akinesia with low complications. The current study recommends that subtenon block is a good alternative to extraconal block for cataract surgery.

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Conflicts of interest

There are no conflicts of interest.

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