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Comparative study between medial canthus episcleral block versus peribulbar block in intracapsular cataract surgery

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Abstract

Background: Ophthalmic regional anesthesia is now the most common anesthetic technique used for eye surgeries. There are various modes of needle-based ophthalmic anesthesia which are retrobulbar, peribulbar, and episcleral. The sub-Tenon episcleral anesthesia technique became a potential alternative to the retrobulbar and peribulbar anesthesia in most of the anterior and posterior segment eye surgeries; this is due to its better safety profile and tolerability than the other blocks. The aim of this study was to compare between medial episcleral block and peribulbar block in intracapsular cataract surgery as regards anesthesia and akinesia of the eye, the need of supplementation of local anesthetic, and finally the safety profile of each block. This was a prospective, comparative, randomized, double-blinded clinical study. It was carried out on 60 patients that were scheduled for intracapsular cataract surgery in ophthalmic surgery unit. The patients were randomly allocated into two equal groups; group A received medial canthus episcleral block technique and group B received peribulbar block technique.

Results: Results of this prospective, comparative, randomized, double-blinded study showed no statistical difference between the two groups as regards demographic and vital data. As regards Akinesia score, the ESA group had better akinesia score at 1, 5, and 10 min and at the end of surgery than PBA group (*P* value, 0.001). No patient in the ESA group received supplemental injection via inferotemporal peribulbar block technique, while 66.7% of PBA group was in need of supplementation. Regarding time to onset of acceptable akinesia score; ESA group had a faster onset with high statistical significance (*P* value, 0.001). Numeric pain scale was better in ESA group than PBA group with high statistical significance. There were chemosis after injection in two of the ESA group (6.6%). On the other hand, slight pricking pain at the end pf surgery developed in two cases in the PBA group.

Conclusion: Medial canthal episcleral technique proved to be superior in motor akinesia score, time to onset of acceptable akinesia score, and numeric pain scale in comparison to peribulbar anesthesia with high statistical significance between the two groups. Both techniques proved to be safe with no incidence of major complications.

Keywords: Episcleral anesthesia, Peribulbar anesthesia, Intracapsular cataract surgery

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Background

Most of the eye surgeries are performed under ophthalmic regional anesthesia either alone or as adjunct to general anesthesia for its postoperative analgesic effect as in pediatric eye surgeries (Nouvellon et al. 2010).

Local anesthetic techniques of ophthalmic regional anesthesia vary from an akinetic injection techniques to a non-akinetic topical technique. Regarding akinetic techniques, each technique has its own risk/benefit profile and proven to be highly successful if performed correctly. These techniques are mainly peribulbar, retrobulbar, and episcleral (Jaichandran et al. 2013).

In 1884, Knapp explained a technique of injecting cocaine for local anesthesia of the eye. In the same year, Turnbull explained a technique of injection of local anesthetic in the episcleral plane. In 1936, Atkinson developed the retrobulbar technique (Kumar 2011).

Intraconal retrobulbar block anesthesia (RBA), which consists of a 3–5-mL injection of local anesthetic solution into the musculo-membranous cone of the orbit, remained the technique of choice for ophthalmic blocks for decades because of its high efficacy (Carneiro et al. 2016).

Peribulbar anesthesia technique is performed by injecting the local anesthetic extraconal outside the muscle cone, and the needle tip is directed away lateral to the apex of the muscle cone (containing the optic nerve and the other vascular structures). This makes the technique theoretically safer than the retrobulbar one (Kumar and Gayer 2008).

Akinetic block using a needle, such as intraconal (retrobulbar), extraconal (peribulbar), and combined intraconal/ extraconal were the commonest techniques practiced around the world. Because of potential specific serious complications including brain stem anesthesia, retrobulbar hemorrhage, ocular perforation, and optic nerve injury, retrobulbar anesthesia has been replaced by less dangerous but much less efficient peribulbar anesthesia (Guerrier et al. 2017).

The medial canthus episcleral technique was originally thought to be a peribulbar technique until subsequent computed tomography (CT) study showed that the local anesthetic solution actually entered the sub-Tenon's space. The block can be performed in any quadrant, but the single-injection inferonasal approach has the advantage of being away from the usual site of surgery and away from the insertion of the superior and inferior oblique muscles (Guise 2012).

In the computed tomography study, volume of less than 3 ml injected dye was confined to the episcleral space, while volumes of 4 ml or more showed spread to rectus muscle sheaths, optic nerve sheath, eyelid, and subconjunctival space which was noticed in the CT study. This proved the continuity between the episcleral space and these structures and explained also chemosis that occurs with relatively small volumes with episcleral technique. Also, there was explanation for the occurrence of orbicularis muscle block with this technique (Ripart et al. 1998).

The sub-Tenon episcleral anesthesia technique became a potential alternative for the retrobulbar and peribulbar anesthesia in most of the anterior and posterior segment eye surgeries; this is due to its relative safety and efficacy (Jeganathan and Jeganathan 2009).

Aim of the study

The aim of this work was to compare between medial episcleral block and peribulbar block in intracapsular cataract surgery as regards anesthesia and akinesia of the eye, the need of supplementation of local anesthetic, and finally the safety profile of each block (Fig. 1).

Methods

This prospective, comparative, randomized, double-blinded clinical study was carried out in ophthalmic surgery unit from February 2019 to March 2020. After institutional Ethical Board approval and obtaining informed written patients' consent, 60 patients from both sexes, ASA physical status I and II and having an Axial globe length ranging from 22 to 30 mm scheduled for intracapsular cataract surgery under medial canthus episcleral and peribulbar blocks were included in the study.

Exclusion criteria

- Refusal of procedure or participation in the study
- Patient under age of 21 years
- Infection at site of injection
- Psychiatric illness or uncooperative patient
- Coagulopathy, use of anticoagulants, or antiplatelet therapy
- Known allergies to local anesthetics drugs
- Uncontrolled glaucoma
- Recent surgical procedure on the same eye within one month
- Single eye

Patients were randomly divided in to two groups by computer generated randomization, group A and group B:

- *Group A (30 patients).* Medial episcleral anesthesia *(ESA) technique*
- *Group B (30 patients).* Peribulbar anesthesia *(PBA) technique*

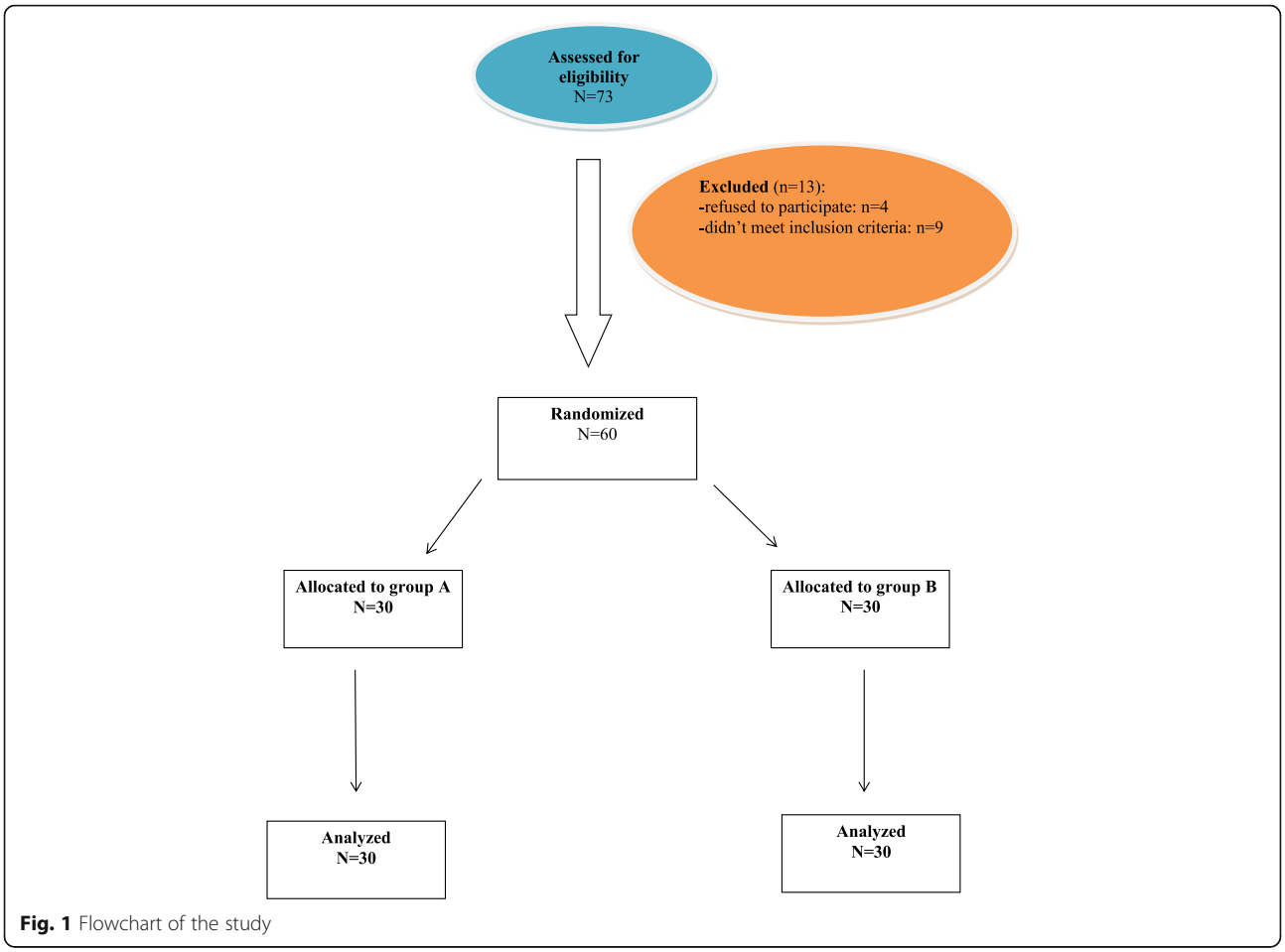

Fig. 1 Flowchart of the study

Pre-operative settings

History, clinical examination and routine investigations including complete blood count (CBC), fasting blood sugar (FBS), liver function test (LFT), kidney function test (KFT), electrocardiogram (ECG), prothrombin time (PT), and activated partial thromboplastin time (aPTT) were performed to all patients beside routine ophthalmic investigations as biometry. An intravenous (IV) 20-gauge cannula was inserted.

Monitoring

The patients were monitored during the procedure using pulse oximetry, non-invasive blood pressure (NIBP), and electrocardiogram (ECG).

Anesthetic technique

The patients were fasting for at least 6 h preoperatively. The procedure was done in the operating rooms (OR) under complete aseptic technique. Supplemental oxygen was given through nasal prong at a flow rate of 3 L/min.

The preparations used for each patient were the following:

1. Sterile towels, sponges, 4-inch gauze packs and povidone iodine 5% for sterilization, sterile gloves, 25 G × 5/8-in. needle and 25 G × 1-in. needle
2. The patients were premedicated with intravenous 4 mg ondansetron
3. No sedation was given to the patients; only local anesthetic eye drops were applied before the performance of the block.
4. The local anesthetic drugs that were used are the following:
   (a) A 20–ml vial of 0.5% bupivacaine hydrochloride equivalent to 5 mg/ml
   (b) A 50-ml vial of 2% lidocaine hydrochloride equivalent to 20 mg/ml with 1500 IU hyaluronidase dissolved in the vial (30 IU/ml)
   (c) A mixture of 2.5 ml of lidocaine-hyaluronidase and 2.5 ml bupivacaine were prepared in the syringes (5 ml total volume).

Under complete aseptic condition, three drops of topical anesthetic (0.4% benoxinate hydrochloride) were applied to the cornea and conjunctiva for three times at 60-s intervals. The patient was placed in supine position.

Table 1 Patients' characteristics and duration of surgery

		Group				*P* value	Sig
		A		B			
		Mean	± SD	Mean	± SD		
Age (years)		57.57	6.73	55.90	7.92	0.384	NS
duration of surgery (min)		17.0	6.10	17.50	6.53	0.78	NS
Sex	Male	16	53.3%	18	60.0%	0.6	NS
	Female	14	46.7%	12	40.0%		
ASA	I	14	46.7%	15	50.0%	0.79	NS
	II	16	53.3%	15	50.0%		

The eyelids and the surrounding areas were cleaned with povidone iodine 5% solution.

Group A: medial episcleral anesthesia (ESA) group

The 25 G × 5/8-in. needle is inserted to contact the conjunctiva between the eyeball and the semilunaris fold, at a depth of less than 1 mm, with the bevel directed toward the globe. The needle then will be shifted slightly medially displacing the semilunaris fold and caruncle away from the eyeball. The needle will be advanced in anteroposterior direction, with the globe is directed slightly medially by the needle, until a "click" will be perceived, at a depth of approximately 15 mm. At this moment, the globe will return to the primary gaze position. This point represents a reliable depth marker that confirms the episcleral location of the tip of the needle at which the 5-ml local anesthetic mixture is injected.

Group B: peribulbar anesthesia (PBA) group

The 25 G × 1-in. needle is inserted transcutaneously through the inferotemporal approach at the junction between the medial two third and the lateral third of the lower orbital margin in such a way the bevel is facing the globe and the tip toward the floor of the orbit until the needle passes through the orbital septum it is directed then posteriorly tangential to the floor of the orbit for 25-mm length at which the 5-ml local anesthetic mixture is injected.

Table 2 Comparison between group A and B as regards MAP

MAP (mmHg)	Group				*P* value	Sig
	A		B			
	Mean	± SD	Mean	± SD		
Basal	89.33	5.83	87.83	5.03	0.291	NS
5 min	95.50	6.34	94.17	4.56	0.354	NS
10 min	95.83	5.74	94.00	4.81	0.185	NS
15 min	96.25	5.37	93.75	4.72	0.093	NS
20 min	93.50	4.74	95.45	3.50	0.293	NS

Table 3 Comparison between group A and B as regards heart rate

HR (beats per min)	Group				*P* value	Sig
	A		B			
	Mean	± SD	Mean	± SD		
Basal	73.90	7.85	71.10	6.90	0.148	NS
5 min	78.20	7.94	75.20	7.45	0.137	NS
10 min	77.83	8.19	75.00	8.00	0.180	NS
15 min	77.37	8.59	75.54	7.62	0.438	NS
20 min	79.10	7.95	78.36	7.30	0.827	NS

Ocular compression was applied for 5 min by Honan intraocular pressure IOP reducer adjusted at 20 mmHg.

Data collection

Motor blockade (akinesia score) was used as the main index of anesthesia effectiveness for both groups. It assessed the block using a 12-point score (12-point akinesia score) as 0 (no movement), 1 (flicker), 2 (full movement) for the four recti muscles, levator palpebrae, and orbicularis oculi (total score 12). Successful block was defined as an ocular motility score between 0 and 6. This score compared between the two groups at 1, 5, and 10 min after injection and at the end of the surgical procedure. The incidence of incomplete blockade (score > 6 after 10 min from local anesthetic injection) with a need for supplemental injection in the two groups was recorded. Recording of the akinesia score was done in a blinded manner by an investigator unaware of the technique of injection.

Akinesia of the eye was judged to be insufficient after 10 min; supplemental injection was given using the same mixture of 5 ml volume (2.5 ml lidocaine-hyaluronidase + 2.5 ml bupivacaine 0.5%) by the inferotemporal peribulbar technique for both groups as it is considered the classic well-tested technique which is used as a supplement.

Numeric pain scale for each block was recorded on a 10-poins-scale during surgery being 0 indicating no pain while 10 representing the worst possible pain. Double

Table 4 Comparison between ESA and PBA as regards oxygen saturation

SPO_2 (percent)	Group				*P* value	Sig
	A		B			
	Mean	± SD	Mean	± SD		
Basal	97.53	.51	97.73	.58	0.162	NS
5 min	98.90	.31	98.77	.43	0.171	NS
10 min	98.90	.31	98.77	.43	0.171	NS
15 min	98.88	.34	98.79	.41	0.449	NS
20 min	98.90	.32	98.82	.40	0.614	NS

Table 5 Comparison between group A and B as regards respiratory rate

RR (breaths per min)	Group				*P* value	Sig
	A		B			
	Mean	± SD	Mean	± SD		
Basal	12.67	.66	12.60	.67	0.70	NS
5 min	12.80	.71	12.63	.56	0.31	NS
10 min	12.67	.61	12.63	.56	0.82	NS
15 min	12.79	.88	12.58	.58	0.34	NS
20 min	12.80	.92	12.82	.87	0.96	NS

blind data collection was done in which the investigator of the numeric pain score was unaware by the technique and also the patient was unaware by the technique.

Hemodynamic data as mean arterial blood pressure (MAP), heart rate (HR), respiratory rate (RR), and peripheral oxygen saturation (SPO_2) were recorded before anesthesia and every 5 min, immediately after both blocks till the end of surgery.

Duration of surgery in minutes for every patient in each group was recorded.

Primary outcomes

Akinesia score was the main parameter of the quality of anesthesia; time to onset of accepted akinesia score, the need of supplemental injection in each group, and the numeric pain scale were the primary outcomes of this study.

Secondary outcomes

Comparison between the two groups as regards safety profile and the incidence of complications

Data management and analysis

Using STATA program, setting alpha error at 5% and power at 90% results from previous study (Ripart et al. 2000) showed that supplemental injection rate of episcleral block group as 1% compared to 39% in peribulbar block group (Ripart et al. 2000) based on this the needed sample size is 27 case per group rounded to 30 per group (total number is 60).

Sample size

Thirty patients in each group (total 60 patients):

- *Group A (30 patients).* Medial episcleral anesthesia *(ESA) technique*
- *Group B (30 patients).* Peribulbar anesthesia *(PBA) technique*

The collected data was revised, coded, tabulated, and introduced to a PC using Statistical Package for Social Science (IBM Corp. released 2011, IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

Data were tested for normality with Shapiro-Wilk test and expressed as mean (standard deviation) for parametric numerical data or median (interquartile range) for non-parametric numerical data.

The *P* value was considered significant as the following:

P value > 0.05, non-significant (NS)
P value < 0.05, significant (S)
P value < 0.01, highly significant (HS)

Results

Demographic data

The two groups were compared regarding patients' age, sex, ASA physical status, and duration of surgery with no significant statistical difference (Table 1).

Vital data

Mean arterial blood pressure

There was no statistical difference between group A and B as regards MAP (Table 2).

Table 6 Comparison between group A and B as regards Akinesia score

Time	Group A (*n* = 30)	Group B (*n* = 30)	*P* value
Akinesia at 1 min	2 (1–3)	8 (6–10)	0.001*
Akinesia at 5 min	1 (1–2)	7 (6–9)	0.001*
Akinesia at 10 min	1 (1–2)	7 (6–9)	0.001*
Akinesia at the end of surgery	1 (1–2)	4 (3–6)	0.001*
Need for supplement	0	20 (66.7%)	0.001*

Group A episcleral anesthesia, *Group B* peribulbar anesthesia, *n* number of cases
Data are presented as median (IQR) or number of patients
**P* < 0.05 is considered statistically significant between the two groups

Table 7 Comparison between group A and B as regards onset time to acceptable akinesia score

Variable	Group A (n = 30)	Group B (n = 30)	P value
Onset time to acceptable akinesia (min)	1 (1–1)	11 (1–11)	0.001*

Group A episcleral anesthesia, *Group B* peribulbar anesthesia, *n* number of cases
Data are presented as median (interquartile range)
*$P < 0.05$ is considered statistically significant between the two groups

Heart rate

Both groups are compared with no statistical difference (Table 3).

Oxygen saturation

No statistical difference was found between the two groups (Table 4).

Respiratory rate

The two groups showed no statistical significance as regards respiratory rate (Table 5).

Akinesia score

Comparison between group A and group B showed high statistical significance in the motor akinesia score at 1, 5, and 10 min and at the end of surgery as the motor score was better in the group A (Table 6).

Onset time to acceptable akinesia score

There was a high statistical significance between the two groups in which group achieved the onset of acceptable akinesia score earlier than group B (Table 7).

Numerical pain scale (NPS)

On comparing both groups, there was a statistical significance in which group A showed a better NPS than group B (Table 8).

Complications

There were no major complications in both groups. In group A (the medial episcleral technique), two cases (6.6%) developed slight chemosis which resolved on gentle massage. In group B, two cases of those who did not receive supplementation and there akinesia score was 6 developed slight pricking sensation at the end of surgery. Furthermore, their akinesia score worsened at the end of surgery to 7 and there pain score was higher in relation to those cases who did not receive supplementation.

Table 8 Comparison between group A and B as regards NPS

Variable	Group A (n = 30)	Group B (n = 30)	P value
Numerical pain score	0 (0–0)	3 (2–3)	0.001*

Group A episcleral anesthesia, *Group B* peribulbar anesthesia, *n* number of cases
Data are presented as median (interquartile range)
*$P < 0.05$ is considered statistically significant between the two groups

Discussion

In our study, ESA group had a better akinesia score than PBA group at the serial intervals of time (1, 5, and 10 min) after local anesthetic injection and at the end of surgery with significant statistical difference (P value = 0.001). This result was similar to the result in a study that was performed by Ripart et al. They compared between medial canthal episcleral technique and peribulabar technique and concluded that ESA had better akinesia score at different intervals of time and lower need for supplementation than the PBA group (Ripart et al. 2000).

Although the injected volume of local anesthetic was lower in our study than that of Ripart et al. study (5 ml vs 6–11 ml), there was no need for supplementation regarding the ESA group as we used a predetermined volume of 5 ml of a mixture of local anesthetics for both groups. While in Ripart et al. study, they did not use a fixed volume of injected local anesthetic and depended on clinical signs of orbital fullness which was adjusted to each patient in both groups.

In contrast to our study, Ashok et al. found no statistical significance between the two groups as regards the akinesia score. However, there was a discrepancy between the volume injected in the two groups opposite to our study, as they predetermined a volume of 10 ml for PBA which was divided into 7 ml injected in the inferotemporal site and 3 ml injected in the superonasal site, while in the sub-Tenon anesthesia they injected a volume of 3 ml of local anesthetic mixture (Ashok et al. 2018).

In the PBA group in our study, 33.3% of patients did not need supplementation, with a total volume of 5 ml of local anesthetic was injected. On the other hand, 66.7% of patients received additional 5 ml as a supplementation with total volume of 10 ml, which was less than the total volume needed in Ripart et al.'s study. In Ripart et al.'s study, the PBA needed supplementation in 39% of cases; however, the injected volume was not predetermined, while in our study 66.7% of patients needed supplementation after injection of 5 ml of local anesthetic mixture.

In our study, there were two cases in the PBA group which had a worsened akinesia score at the end of surgery in which the duration of surgeries were 30 and 35 min. This phenomenon of regressed motor block did not happen in the ESA group in which the akinesia score was maintained at the end of surgery. This phenomenon was recorded also in Ripart et al. study, as they also

recorded three cases with regressed motor score before the end of surgery.

As regards onset of accepted blockade, there was a faster onset in the ESA group than the PBA group with high statistical significance (*P* value = 0.001). This result was similar to both studies of Ripart et al. and Ashok et al.

Regarding pain scale, the ESA group in our study achieved better numeric pain scale than the PBA group with highly significant statistical data (*P* value = 0.001). This result was supported with Ashok et al. study which found similar result.

In our study, there were no major complications (optic nerve injury, retrobulbar hemorrhage, globe perforation, strabismus, or brainstem anesthesia) for both groups. As regards the ESA group, there were two cases that developed ocular chemosis (6.6% of patients) which was reported also in Ashok et al. study as a minor complication. Furthermore, there were only two cases in the PBA group that developed slight pricking pain at the end of surgery.

As regards safety of ESA technique, there was also a study which was performed on 2031 patients by Nouvellon et al. In this study, there were 65 patients (3.2%) that developed minor complications such as subconjunctival hemorrhage, chemosis, and others, while only 1 patient (0.05%) developed retrobulbar hemorrhage. This result was near to that of our study in which there was a low incidence of minor complications and a very minute incidence of major complications related to Nouvellon et al. study (Nouvellon et al. 2004).

Nouvellon et al. stated that ESA theoretically has many benefits regarding safety. As the episcleral space is avascular, the needle was inserted for a short distance and there was a very low incidence of occurrence of scleral staphyloma in the inferonasal area (Nouvellon et al. 2004).

In their study, Nouvellon et al. reported that there was a great correlation between the incidence of complication and performance of the block by inexperienced operator. So they concluded that safety of the block depends also on practice and experience of ESA (Nouvellon et al. 2004).

Conclusion

In this study, medial canthal episcleral technique proved to be superior in motor akinesia score, time to onset of acceptable akinesia score, and numeric pain scale in comparison to peribulbar anesthesia with high statistical significance between the two groups. Both techniques proved to be safe with no incidence of major complications.

Abbreviations

ESA: Episcleral anesthesia; PBA: Peribulbar anesthesia; RBA: Retrobulbar anesthesia; ASA: American Society of Anesthesiology; Sig: Significance; SD: Standard deviation; HR: Heart rate; S: Significant; NS: Non-significant; HS: Highly significant; MAP: Mean arterial pressure; RR: Respiratory rate; SPO_2: Oxygen saturation

Acknowledgements

Not applicable.

Authors' contributions

AF designed the study; revised literature; performed the analysis; followed the patients; measured vital data, motor akinesia score, onset of accepted akinesia score, and numeric pain scale; and wrote the manuscript. *MZ* designed the study, performed the analysis, and wrote and critically revised the manuscript. *SS* revised literature, performed the analysis, and critically reviewed the manuscript. *AM* revised literature, followed the patients, collected the data, performed the analysis, and critically reviewed the manuscript. All authors approved the final version of the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Approval of research ethical committee of Faculty of Medicine, Ain-Shams University, was obtained (code number FMASU 323/2018) and informed written consents were obtained from the patients after description of the procedure and its potential complications.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

Ashok A, Krishnagopal S, Jha KN (2018) Comparison of peribulbar anesthesia with sub-Tenon's in manual small incision cataract surgery. TNOA J Ophthalmic Sci Res 56:67–70

Carneiro HM, Teixeira KI, De Ávila KM et al (2016) Comparison of needle path, anesthetic dispersion, and quality of anesthesia in retrobulbar and peribulbar blocks. Regional Anesthesia Pain Med 41:37–42

Guerrier G, Rothschild PR, Lehmann M et al (2017) Impact of video technology for improving success of medial canthus episcleral anesthesia in ophthalmology. Regional Anesthesia and Pain Medicine 42:757-759

Guise P (2012) Sub-Tenon's anesthesia: an update. Local and Regional Anesthesia 5:35–46

Jaichandran V, Nair AG, Gandhi RA, Prateeba N (2013) Brainstem anesthesia presenting as contralateral third nerve palsy following peribulbar anesthesia for cataract surgery. Acta Anaesthesiologica Taiwanica 51:135–136

Jeganathan VSE, Jeganathan VP (2009) Sub-Tenon's anaesthesia: a well-tolerated and effective procedure for ophthalmic surgery. Current Opinion in Ophthalmology 20:205–209

Kumar C, Gayer S (2008) Ophthalmic regional anesthesia techniques. Minerva Anestesiologica 74:23–33

Kumar CM (2011) Needle-based blocks for the 21st century ophthalmology. Acta Ophthalmol 89:5–9

Nouvellon E, Cuvillon P, Ripart J (2010) Regional anesthesia and eye surgery. Anesthesiology 113:1236–1242

Nouvellon E, Hermite JL, Chaumeron A et al (2004) Medial canthus episcleral single injection block. Anesthesiology 100:370–374

Ripart J, Lefrant JY, Vivien B et al (2000) Ophthalmic regional anesthesia: medial canthus episcleral (sub-Tenon) anesthesia is more efficient than

peribulbar anesthesia. Anesthesiology 92:1278–1285
Ripart J, Metge L, Prat-Pradal D et al (1998) Medial canthus episcleral (sub-Tenon) anesthesia imaging. Anesth Analg 87:42–45

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