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COMPARISON OF RETROBULBAR, SUB-TENON ANESTHESIA AND MEDIAL CANTHUS EPISCLERAL ANESTHESIA FOR 25-GAUGE POSTERIOR VITRECTOMY

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Purpose: The aim of the study is to compare the efficacy, safety, and globe akinesia between retrobulbar anesthesia, sub-Tenon anesthesia, and medial canthus episcleral anesthesia for 25-gauge posterior vitrectomy.

Methods: A total of 340 25-gauge vitrectomy data sheets were retrospectively collected between November 2017 and June 2019. Ninety patients were included in the study. These patients were matched by sex and age to receive retrobulbar anesthesia (group 1, n = 30), sub-Tenon anesthesia (group 2, n = 30), and medial canthus episcleral anesthesia (group 3, n = 30). Globe akinesia was recorded after the injection of anesthetic at 2, 5, and 10 minute time intervals. Patients were asked to rate the pain during administration of anesthesia, during surgery, and postoperatively using the visual analog pain scale.

Results: For a perfect block, at 10 minutes, retrobulbar outperformed both sub-Tenon and medial canthus episcleral anesthesia which seemed quite similar. During administration, the three techniques did not show statistically different effects on pain. Regarding perioperative pain, retrobulbar outperformed medial canthus episcleral anesthesia.

Conclusion: All three techniques allowed for safe surgery. Retrobulbar obtained the best results, although sub-Tenon proved to be a valid alternative. Medial canthus episcleral anesthesia obtained mostly good and fair blocks and acceptable pain levels during surgery. Further studies should investigate whether optimal anesthetic efficacy can be obtained with sub-Tenon and medial canthus episcleral techniques when higher volumes are used.

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Vitreoretinal surgery has traditionally been performed under general anesthesia (GA), but local anesthesia (LA) has increased in popularity in recent years.[1–4] Nevertheless, a systematic review failed to locate relevant clinical evidence to support or refute a pars plana vitrectomy performed with various modalities of LA versus GA.[5] However, the advantages of LA may include more rapid return to ambulation for the patient, the ability to perform outpatient procedure,[6] avoidance of complications of GA, and allowing the patient to adopt the correct postoperative posture straight away.[7] Several methods of LA have been described.

Retrobulbar (RB) is commonly used for ocular posterior segment surgery. Rare but serious complications have been reported with this anesthesia, including globe perforation,[8] injury to optic nerve,[9] and cardiorespiratory arrest.[10] For this reason, many physicians substitute this technique. Previous studies have demonstrated that sub-Tenon anesthesia (STA)[11–14] and medial canthus episcleral anesthesia (MCEA) can be safe.[15–17]

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Sub-Tenon anesthesia became popular in the 1990s as a simple and safe alternative to needle-based eye blocks, thanks to the work reported by Stevens.[18] The reasons for the growing interest in this block are as follows: First, it produces satisfactory anesthesia for most intraocular procedures, and second, it avoids the inherent risks of needle-based blocks, such as globe perforation and optic nerve injury.

Medial canthus episcleral anesthesia did not gain wide acceptance until 1989, when Mein and Flynn[19] recommended its use as a perioperative complement to RB anesthesia. It was subsequently proposed as the sole anesthesia technique for various intraocular procedures. Its safety is being investigated on a large scale, and the initial results seem promising.[20,21]

The aim of the study is to compare the efficacy, pain recording, safety, and globe akinesia of RB, STA, and MCEA for 25-gauge posterior vitrectomy.

Methods

We conducted a retrospective study with matched comparisons of akinesia and pain perception between different anesthetic techniques in patients undergoing vitrectomy for macular surgery. Our study was made possible by the adoption of standardized measurements of akinesia, extraocular muscle motility, and pain scores which become a part of a surgical quality improvement program before our study was conducted. After local ethics committee approval, a total of 340 25-gauge vitrectomy data sheets were collected between November 2017 and June 2019. A routine surgical data collection was already in place at our clinic, which allowed us to collect high-quality and complete data from our clinical charts. Ninety patients were included in the study with the aim of matching (1:1:1) 30 patients for each LA group using the following criteria for each matched group of three patients: sex and age within a 10-year span. Patients who had had previous ocular surgery, other than cataract surgery, were excluded. Because of difficulties in matching patients, we accepted two non–sex-matched patients in two triplets. We included patients who underwent vitrectomy for three conditions: epimacular membrane, macular hole, and vitreous hemorrhage of any cause, unless associated with retinal detachment or severe proliferative diabetic retinopathy. There was no matching for diagnosis or surgeon because the two surgeons used these three LA techniques interchangeably; however, patients for whom RB was selected because clinical charts reported they were poorly cooperative were excluded. Moreover, we excluded the patients who needed the usage of narcotic or amnestic agents because they could confound the patient's ability to accurately record their pain perception. Patients' characteristics and indications for posterior vitrectomy are shown in Table 1. A peripheral intravenous catheter was inserted, and monitoring included continuous electrocardiography, pulse oximetry, and automated noninvasive blood pressure measurements. Before induction of blockade, conjunctival cul-de-sac was anesthetized with oxybuprocaine drops three times in 15 minutes. No additional subconjunctival anesthetic was delivered for STA or MCEA. In each group, the local anesthetic used was 5 mL of mepivacaine hydrochloride at 2%.

For the RB, a 27-gauge, 31-mm-long needle, with bevel facing the globe, was inserted through the skin in the inferotemporal quadrant as far laterally as possible, just above the junction of the inferior and lateral orbital walls. The initial direction of the needle was tangential to the globe. Once past the equator, as gauged by the axial length of the globe, the needle was allowed to go upwards and inwards. With the eye in primary gaze, the local anesthetic agent was injected.[22]

The STA was given by making a conjunctival incision in the inferonasal quadrant with blunt-tipped Westcott scissors and bluntly dissecting the sub-Tenon layer off the sclera. Then a blunt cannula was introduced into the ST's space, and local anesthetic was administered. The injected local anesthetic spread across the potential ST's space and produced anesthesia and akinesia by diffusing into intraconal and extraconal zones.[23]

For the MCEA, a 26-gauge, short-bevel needle was inserted to contact the conjunctiva between the eyeball and the semilunaris fold, at a depth of less than 1 mm. The needle was then shifted slightly, medially displacing the semilunaris fold and caruncle away from the eyeball. The needle was then advanced in an anteroposterior direction, with the globe directed slightly medially by the needle until a "pop" was perceived.[15,16] At this point, the globe returned to the primary gaze position. After an aspiration test, the local anesthetic was slowly injected.

For each group of patients, an infusion of paracetamol 1,000 mg/100 mL was administered but no narcotic or amnestic agents were used before or during surgery.

Globe akinesia was recorded after the injection at 2, 5, and 10 minute time intervals. A scoring system was used to evaluate the akinesia. Eye movement in four directions was elicited superiorly, inferiorly, nasally, and temporally. Movements for each muscle of the eye were assessed using the following scale: 0 = no movement, 1 = reduced movement, and 2 = normal movement. The sum of the scores in each quadrant was

Table 1. Patients' Baseline Characteristics

	Technique of Anesthesia Administration		
	RB (N = 30)	Sub-Tenon (N = 30)	Canthal (N = 30)
Sex,* n (%)			
Male	14 (32.0)	13 (34.0)	13 (34.0)
Female	16 (35.0)	17 (32.5)	17 (32.5)
Age,† years			
Mean ± SD	68.7 ± 8.9	68.6 ± 7.8	66.8 ± 8.7
Range	51–88	51–88	51–88
Indication for PPV, n (%)			
Epimacular membrane	18 (60.0)	15 (50.0)	21 (70.0)
Macular hole	8 (26.7)	12 (40.0)	9 (30.0
Vitreous hemorrage	4 (13.3)	3 (10.0)	0
Duration of surgery, minutes			
Mean	42.6 ± 7.1	42.2 ± 8.8	43.3 ± 8.5
Range	31–56	30–58	32–60

The patients were matched by sex* (chi-square: $P = 0.9560$) and age† (one-way analysis of variance: $P = 0.5999$) to RB (Group 1, n = 30), STA (Group 2, n = 30), and MCEA (Group 3, n = 30).
PPV, pars plana vitrectomy.

noted, and the times taken to achieve a score of less than 6 and to total akinesia of the eye (a score of zero) were recorded. The block score results as assessed by the surgeon were categorized such that 0 represented a perfect block or excellent operating conditions; 1 to 3, a good block or adequate conditions for surgery; 4 to 6, a fair block or adequate but potentially compromising surgical technique; and 7 or more, a poor block or inadequate for surgery.[24]

One hour after surgery, each patient was shown a visual analog pain scale with numeric and descriptive ratings from 1 (no pain and discomfort) to 4 (severe pain and discomfort). Patients were asked to rate the visual analog pain scale for surgical conditions, pain during administration of anesthesia, pain during surgery, and postoperative pain.[2]

Statistical Analysis

Outcome measures were summarized according to the usual methods of descriptive statistics: mean, SD, and range for quantitative continuous variables and frequency—absolute and relative (percentage)—for qualitative variables. Sex distribution and age of patients belonging to the three technique samples were compared using the chi-square test and one-way analysis of variance, respectively. Ordinal logistic regression was used to compare the proportion of subjects with all muscles blocked across techniques at each time point. The effect of anesthetic technique on the motility of ocular rectus muscles was measured by summing up the scores registered on the four muscles and treated as a continuous variable in the analysis. The mixed-effect linear model was used to compare effects among techniques accounting for time (fixed effect) and patients (random effect). Tukey's post hoc test for multiple comparisons was used to compare effect between couples of techniques. Because of the semiquantitative score of the anesthesia technique effect on single rectus muscles, differences on akinesia among the four rectus muscles were analyzed within the same anesthetic technique using mixed-effects ordinal logit models accounting for an interaction with time. Ordinal logistic regression was used to assess the influence of the different anesthetic techniques on pain perceived by patients at administration of anesthesia as well as perioperatively. Analysis was made also using the dichotomized pain score (mild or moderate vs. no pain or discomfort). Patient matching had no effect on estimates and was thus ignored in final analyses. All the statistical analyses were performed using software SAS 9.4 (SAS Institute, Cary, NC). Statistical tests were considered significant when $P < 0.05$.

Results

Akinetic Effect: Global Akinesia Score

Figure 1 shows the number and percentage of patients with different levels (perfect = 0, good=1–3, fair=4–6, and poor = 7+) of akinesia for each technique at 2′, 5′, and 10′. Retrobulbar and STA techniques showed similar proportions of akinesia level at 2′ and 5′ and outperformed MCEA that showed levels of akinesia from fair (score 4–6) to poor (score 7 or more). At 10 minutes, the RB technique outperformed both STA and MCEA, which seemed quite similar. We therefore considered an overall perfect akinetic effect as a complete block (all muscles at level 0).

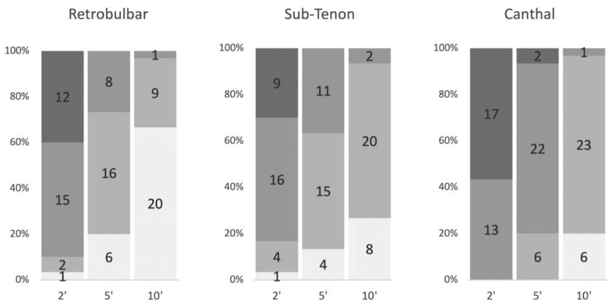

Fig. 1. Number of patients with the akinesia score (perfect , good , fair , and poor) for each technique at 2, 5, and 10 minutes. Analysis of the number of muscles completely blocked among anesthesia techniques at time 10′: canthal versus RB OR = 0.13 (95% CI: 0.03–0.40, P = 0.0005), sub-Tenon versus RB OR = 0.18 (95% CI: 0.06–0.55, P = 0.0026), and canthal versus sub-Tenon OR = 0.69 (95% CI: 0.21–2.30, P = 0.5432).

Given the fact that RB akinesia had a more consistent effect on all muscles, the difference among techniques become more evident in this analysis and RB outperformed STA and MCEA at 5 and 10 minutes. In fact, at 5 minutes, 20.0%, 13.3%, and 0.0 of the subjects were completely blocked with the three techniques, respectively, and these were 66.7%, 26.7%, and 20.0% at 10 minutes (Figure 2). Ten minutes after anesthesia administration, the odds ratio (OR) of complete block versus RB was 0.13 (95% confidence interval [CI]: 0.04–0.404, P = 0.0005) for MCEA and 0.18 (95% CI: 0.06–0.55, P = 0.0026) for STA. No statistical difference was found between MCEA and STA (P = 0.5432).

Effect of the Techniques Across the Muscles

The relative effect of the anesthetic techniques varied across muscles. Regarding the motility of superior, inferior, and lateral muscles, MCEA was inferior to RB (P = 0.0069, P = 0.0002, and $P < 0.0001$, respectively) and STA (P = 0.0182, P = 0.0004, and P = 0.0002, respectively). The three techniques showed effects statistically not significant on the medial muscle (P = 0.5509). On the other hand, STA showed akinesia levels not statistically different to RB for all of the rectus muscles.

Levels of Akinesia Among the Four Rectus Muscles Within the Same Anesthetic Technique

Within the same anesthetic technique, we looked for different levels of akinesia between the four rectus muscles. Both RB and STA showed differences statistically not significant in akinesia among the rectus muscles (P = 0.4660 and P = 0.5862, respectively). On the other hand, MCEA showed a significant difference in akinesia levels among the rectus muscles (P = 0.0005). In detail, the lateral muscle showed a statistically significant worse performance than superior (P = 0.0007), medial (P = 0.0001), and inferior muscle (P = 0.0302; Table 2).

Pain During Administration of Anesthesia

The three techniques during the administration of anesthesia did not show statistically different effects on pain as perceived by patients, although MCEA and STA yielded more favorable results than RB, and STA yielded more favorable results than MCEA (Table 3). Different results were obtained when the pain effect at administration of anesthesia was dichotomized as follows: no pain or discomfort (absence) and mild or moderate pain or discomfort (presence). In this case, STA showed a better result than RB (OR: 0.29, 95% CI: 0.09–0.90, P = 0.0322).

Pain During Surgery

Regarding perioperative pain, RB outperformed MCEA (OR: 4.84, 95% CI: 1.19–19.75, P = 0.0279. Sub-Tenon anesthesia did not show a statistically different effect on pain with respect to RB (P = 0.1404) and MCEA (P = 0.3899). Similar results were obtained when perioperative pain effect was dichotomized as follows: no pain or discomfort (absence) and mild or moderate pain or discomfort (presence). Retrobulbar outperformed MCEA (OR: 5.21, 95% CI: 1.28–21.23, P = 0.0213). Sub-Tenon anesthesia did not show a statistically different effect on pain with respect to RB (P = 0.1771) and MCEA (P = 0.2630; Table 3). All surgical procedures were completed without any adjunctive LA.

Postoperative Pain

All patients reported no pain or discomfort after surgery.

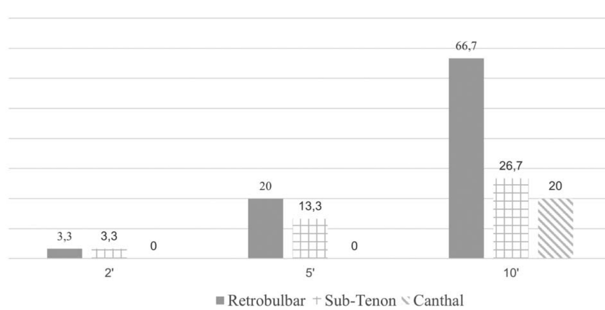

Fig. 2. Percentage of perfect akinesia by the technique and time after administration of anesthesia.

Table 2. Relative Effect of the Anesthetic Technique on Muscle Movement

Technique	Time	Medial	Superior	Inferior	Lateral
Canthal (N = 30)	2′	1.367 (0.615)	1.700 (0.466)	1.700 (0.466)	1.667 (0.479)
	5′	0.700 (0.837)	1.000 (0.743)	1.367 (0.490)	1.467 (0.507)
	10′	0.333 (0.479)	0.267 (0.450)	0.267 (0.450)	0.600 (0.498)
	Average	0.800[g] (0.782)	0.989[a,b,h] (0.814)	1.111[c,d,i] (0.771)	1.244[e,f,g,h,i] (0.676)
	Adjusted	0.773 (0.072)	0.940 (0.065)	1.168 (0.068)	1.249 (0.069)
Sub-Tenon (N = 30)	2′	1.367 (0.809)	1.367 (0.765)	1.367 (0.809)	1.367 (0.850)
	5′	0.633 0.490)	0.700 (0.466)	0.633 (0.490)	0.633 (0.490)
	10′	0.367 0.490)	0.233 (0.430)	0.267 (0.450)	0.500 (0.508)
	Average	0.789 (0.742)	0.767[b] (0.735)	0.756[d] (0.754)	0.833[f] (0.738)
	Adjusted	0.738 (0.085)	0.704 (0.077)	0.850 (0.081)	0.843 (0.082)
RB (N = 30)	2′	1.433 (0.626)	1.467 (0.571)	1.300 (0.651)	1.467 (0.571)
	5′	0.600 (0.498)	0.600 (0.498)	0.700 (0.535)	0.467 (0.507)
	10′	0.100 (0.305)	0.133 (0.346)	0.233 (0.504)	0.133 (0.346)
	Average	0.711 (0.738)	0.733[a] (0.731)	0.744[c] (0.712)	0.689[e] (0.744)
	Adjusted	0.673 (0.086)	0.612 (0.078)	0.817 (0.081)	0.683 (0.082)

Mean score° (SD) by time (minutes) after anesthesia administration and on average.
°Akinesia of rectus muscles was coded as follows: 0 = no movement, 1 = reduced movement, and 2 = normal movement.
Mixed-effect linear models' *P*-values: [a]$P = 0.0069$, [b]$P = 0.0182$, [c]$P = 0.0002$, [d]$P = 0.0004$, [e]$P < 0.0001$, and [f]$P = 0.0002$.
Mixed-effect ordinal logit models' *P*-values: [g]$P = 0.0001$, [h]$P = 0.0007$, and [i]$P = 0.0302$.

Discussion

This study was designed to compare the efficacy, safety, and globe akinesia between RB, STA, and MCEA for 25-gauge posterior vitrectomy. Retinal surgery is a delicate procedure particularly during certain maneuvers such as internal limiting membrane peeling. For this reason, an acceptable anesthesia is required. The performance of vitrectomy systems, the use of small gauges, and execution time of surgery have been reduced over the years. This has gradually contributed to making LA preferable to GA for vitreoretinal surgeons. Moreover, studies have reported that vitrectomy under LA is a more cost-effective compared with GA.[25] We used a scoring system, which allowed us to evaluate the motor activity of the individual muscles separately. The global akinesia score allows us to both evaluate which technique is superior to the other and provide a clinical evaluation of surgical safety. Moreover, we evaluated the effect of the three techniques for the individual rectus muscles to verify whether there were behavioral differences between the immobilized muscles for the three anesthesiologic techniques.

A quick onset of anesthesia with prolonged intraoperative analgesia and better postoperative comfort is a desired goal in local anesthesia for ophthalmic surgery. Although various agents are used for peribulbar block, there is no consensus regarding the best anesthetic agent. In fact, different anesthetics were tested. These substances present different characteristics for induction and duration time. The anesthetics can be used individually or combined or with the addition of adjunctive substances. The purpose of the use of anesthetic mixtures is to take advantage of the characteristics of each medication resulting in a reduced induction time and longer duration. Therefore, combination of local anesthetic medications allows the surgeon to maximize the best aspects and reciprocally compensate for the defects; however, it should be noted that competition can occur at the level of binding sites with a reduction in the individual anesthetizing capacity, whereas the toxic effects seem to demonstrate additive behavior. The choice of anesthetic must be made according to the number of scheduled interventions and according to the expected duration of the surgery. Considering an average time of about 40 minutes for a vitreoretinal surgery for macular pathology, we considered the use of 2% mepivacaine hydrochloride. This anesthetic has induction times similar to lidocaine but with a duration of anesthesia longer than 2 to 3 hours. Because mepivacaine induces vasoconstriction, the addition of adrenaline is not useful.

Hamilton et al[26] reported a RB block of 90%, using a mixture of lidocaine 1.0% and bupivacaine 0.375% added with hyaluronidase 5 U/mL and epinephrine 1:400,000 and injecting different volumes in one or multiple sites. Ali-Melkkilä et al[27] reported a RB block of 71% using a mixture of 2% of lidocaine and 0.5% bupivacaine added with hyaluronidase (75 IU/10 mL of local anesthetic solution). In this study, the RB achieved perfect block in 66.7% of cases, lower than what was reported by the aforementioned studies. This could be secondary to the use of different volumes and different local anesthetics that can affect the onset and

Table 3. Effect of Anesthesia on Pain Perceived by Patients During Administration and During Surgery

Pain Perception	RB (N = 30)	Sub-Tenon (N = 30)	Canthal (N = 30)
During administration			
None	6 (20.0)	14 (46.7)	11 (36.7)
Mild	13 (43.3)	10 (33.3)	11 (36.7)
Moderate	11 (36.7)	6 (20.0)	8 (26.6)
OR (95% CI, *P*)	Ref	0.45 (0.18–1.17, 0.1024)	0.62 (0.24–1.59, 0.3180)
		Ref	1.37 (0.54–3.48, 0.5144)
Mild + moderate	24 (80.9)	16 (53.3)	19 (63.3)
OR* (95% CI, *P*)	Ref	0.29 (0.09–0.90, 0.0322)	0.43 (0.14–1.38, 0.1569)
		Ref	1.51 (0.54–4.24, 0.4334)
During surgery			
None	27 (90.0)	23 (76.7)	19 (63.3)
Mild	2 (6.7)	7 (23.3)	7 (23.3)
Moderate	1 (3.3)	0 (0.0)	4 (13.4)
OR (95% CI, *P*)	Ref	2.98 (0.70–12.70, 0.1404)	4.84 (1.19–19.75, 0.0279)
		Ref	1.63 (0.54–4.92, 0.3899)
Mild + moderate	3 (10.0)	7 (23.3)	11 (36.7)
OR* (95% CI, *P*)	Ref	2.74 (0.64–11.82, 0.1771)	5.21 (1.28–21.23, 0.0213)
		Ref	1.90 (0.62–5.86, 0.2630)

*Analysis of the dichotomized score (mild + moderate vs. none).
Ref, reference group.

the duration of the anesthesia. In addition, additives such as epinephrine and hyaluronidase influence the anesthetic effect as well. If we consider, however, the corresponding scores of the perfect block and the good block, the result rises to 96.7%. The remaining 3.3% results were from a fair block. Therefore, according to the score system, which in our study never achieved a result greater than 6, in 100% of cases, RB achieved a level of akinesia that allowed for surgical safety.

Guise[12] reported a perfect block in 75.5% of cases with STA using a 50/50 mixture of 2% lidocaine and 0.5% bupivacaine with 150 units of hyaluronidase with digital compression was applied to the globe. The mean injected volume was 3.8 mL (range 3–8 mL). In this study, we obtained 26.7% of perfect blocks. This difference is evident and is likely to be attributed to a lower diffusion of mepivacaine not associated with hyaluronidase used in our study. The use of hyaluronidase is useful in promoting the spread of the anesthetic by reducing the induction time, but this can lead to its faster elimination by reducing the effectiveness of anesthesia.

However, similar results are obtained with the sum of the perfect block and good block scores, thus achieving a 93.4% result. In this study, STA also achieved 100% akinesia useful for safe surgery if we add the fair block score equal to 6.6%.

Samir and Gabal[28] reported that MCEA provides a satisfactory akinesia in 76.25% of cases. These authors used 6 mL of a mixture of lidocaine 2% and bupivacaine 0.5% (50/50 mix) with hyaluronidase 15 units/mL with ocular compression. Similarly, the study by Ripart et al[15] used a mixture of equal parts of 0.5% bupivacaine and 2.0% lidocaine with 25 IU/mL hyaluronidase, and the injected volume varied "adjusted to each patient." In this study, MCEA provided a perfect block in 20% of cases, good block in 76.7%, and fair block in 3.3%, allowing for safe surgery in all patients.

Considering the global akinetic effect of the three techniques at 2′, in the MCEA group, no case resulted in a good or perfect akinesia. Instead for the RB and STA, we already had perfect and good blocks at 2′. For these two techniques, the poor block results were similar. In most cases, the three techniques at 2′ resulted in a good block. If we consider the akinetic effect for a safe surgery, given by the sum of perfect, good, and fair block percentages, RB and STA outperformed MCEA. Already at 2′, RB and STA permitted the conditions for safe surgery with respect to MCEA.

At 5′, there are no poor blocks in the RB and STA groups, whereas the MCEA group still has. At 5′, in most cases, the MCEA group presented a fair block with respect to the RB and STA groups. A good block was achieved in half of the cases by RB and STA groups and only in 20% of the MCEA group at 5′. In the MCEA group, no perfect block was achieved at 5′, whereas it was present in RB and STA groups. Therefore, at 5′, RB and STA obtained similar scores for global akinesia and demonstrated better performance with respect to MCEA.

At 10′, there were no poor blocks in the three analyzed groups. Retrobulbar, STA, and MCEA showed similar percentages of fair blocks at 10′. The higher percentage of good blocks was reached by the MCEA followed by STA. At 10′, the higher percentage of perfect blocks was achieved by RB. Therefore, at 10′, RB demonstrated better results as compared with those obtained using the STA and MCEA. Considering the effect of anesthesia for a safe surgery at 10′, all three techniques achieved 100% useful blocks, but it should be noted that most of the blocks achieved by STA and MCEA were good, seeming quite similar.

Considering the consequences of each anesthesiologic technique on the single rectus muscles, it was apparent that each technique had a varied effect on muscle motility. A significant difference was seen in the performance of MCEA with respect to RB and STA on the superior, inferior, and lateral rectus. Instead, the motility of the medial rectus muscle is not influenced by the three techniques.

We evaluated the level of akinesia on the four rectus muscles for each anesthesiologic technique. Retrobulbar and STA affect motility in a similar way. The lateral rectus muscle is the least influenced by MCEA. This is probably due to the fact that this type of anesthesia was performed medially at the level of the caruncle and with a short needle. These conditions could limit the diffusion of the anesthetic, reflected by its incomplete efficacy on the lateral rectus.

In this study, we used 5 mL of anesthetic for each technique. This was performed in an attempt to standardize the maximum amount of anesthetic that can be used. This choice, however, may have penalized those techniques for which it could be useful to use a larger quantity of anesthetic. In fact, for STA and MCEA, the anesthetic is not injected directly into the orbital space and, therefore, a small quantity limits its diffusion influencing the akinetic effect. This does not happen for RB where the anesthetic is injected directly into the orbital space. For this technique, a minimum of 3 mL up to a maximum of 5 mL of mepivacaine was injected.

Regarding the level of perceived pain during anesthesia, there are no statistically significant differences between the three techniques, although the STA and MCEA obtained more favorable results with respect to RB. The tendency observed is as follows: RB caused the most discomfort, followed by the MCEA and the STA which resulted in the least discomfort. This result regarding STA is better shown if the pain scale is simplified into perceived and not perceived.

As for the level of pain perceived during surgery, RB resulted far better than MCEA, obtaining no pain in 90% of cases with respect to the 63.3% of MCEA cases. Sub-Tenon anesthesia did not show statistically significant differences with respect to RB and MCEA, resulting in 76.7% cases with no pain. In any case, no patient in any of the three groups reported severe pain. No patient reported pain postoperatively.

In conclusion, all three techniques allowed for safe surgery, although some differences exist in akinesia and perceived pain scores. For perfect blocks and pain during surgery, RB obtained the best results, although STA proved to be a valid alternative. However, STA with a slightly greater volume may yield similar results to RB. Medial canthus episcleral anesthesia obtained mostly good and fair blocks and acceptable pain levels during surgery, allowing for surgery to be completed safely. We suggest that further prospective or randomized studies should be conducted to investigate whether STA and MCEA can yield optimal anesthesia and akinesia when larger volumes are used.

Key words: retrobulbar, sub-Tenon, anesthesia, medial, canthus, episcleral, vitrectomy, rectus, muscles, block.

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