Pain During Pars Plana Vitrectomy Following Sub-Tenon versus Peribulbar Anesthesia: a randomised trial

Abstract

Purpose

To compare pain during pars plana vitrectomy (PPV) following topical lidocaine jelly and sub-Tenon anesthesia versus peribulbar anesthesia.

Methods

Prospective, single-center, randomized study. Patients who needed PPV for macular hole or epiretinal membrane at the Retina and Vitreous Section of the Department of Ophthalmology in a public hospital of São Paulo were randomly assigned to one of two groups at a ratio of 1:1. In Group ST, patients received topical anesthesia with 2% lidocaine jelly followed by sub-Tenon anesthesia with 2-4 ml of 10% ropivacaine. In Group PB, patients received peribulbar anesthesia with 4-6 ml of 10% ropivacaine. After PPV, patients in both groups were asked to rate the level of pain they felt during the entire procedure (including anesthesia administration and PPV) by pointing at a 0-100 Visual Analogue Pain Scale (VAS). Data regarding demographics, patient characteristics and surgical features were also collected.

Results

Fifty-four patients were enrolled in the study (26 in group ST and 28 in PB). Baseline characteristics, including gender, age and presence of comorbidities, were similar in both groups. The surgery performed was PPV alone in 10 and 14 patients in the ST and PB groups, respectively, and combined phacoemulsification and PPV in 16 and 14 patients in

the ST and PB groups, respectively (p = 0.39, Pearson). Surgery duration (mean ± SD minutes) was similar in the two groups (62 ± 12 for ST and 70 ± 20 for PB, p = 0.09, t-Test) was similar between groups. No patients needed supplemental topical or intravenous anesthesia during the surgery. No sight- or life-threatening complication was observed in both groups. VAS score was significantly lower for the ST compared to the PB group (mean ± SEM, 2.4 ± 0.7 for ST versus 17.5 ± 3.2 for PB, p< 0.0001, Wilcoxon).

Conclusion

In this study of patients undergoing PPV for MH or ERM, topical followed by sub-Tenon anesthesia was more effective in controlling pain during the whole vitrectomy procedure than peribulbar anesthesia. Compared to peribulbar anesthesia which is administered with a sharp needle, sub-Tenon anesthesia administered with a blunt cannula may be associated with a reduced risk of such adverse events as globe perforation, retrobulbar hemorrhage, and inadvertent injection of anesthesia into the optic nerve sheath.

Keywords: Pain, vitrectomy, anesthesia, sub-Tenon.

Introduction

Anesthesia for vitreoretinal surgery is challenging since such surgery is typically longer than cataract phacoemulsification surgery, and patients frequently have such comorbidities as diabetes and hypertension [1, 2]. Traditionally, general anesthesia was more commonly used for vitreoretinal surgery, but more recently there has been a trend for local anesthesia, primarily peribulbar/retrobulbar [3, 4, 5, 6]. However, the use of sharp needles to perform local anesthesia is associated with such complications as retrobulbar hemorrhage and injection of anesthesia into the optic nerve sheath which may result in death [7, 8, 9].

With the adoption of small-gauge pars plana vitrectomy (PPV) and the expansion of surgical indications, less invasive anesthetic procedures such as topical eyedrops anesthesia have been used in some cases [10, 11, 12] and sub-Tenon injection [13, 14, 15, 16]. Optimal anesthesia would not only protect against pain, but would also reduce risks to the patient, avoid the oculocardiac reflex, and also permit early patient mobilization [2].

Sub-Tenon anesthesia has been reported to provide effective anesthesia for vitreoretinal surgery while reducing the risks of using a sharp needle [13, 14, 15, 16]. The current study compares pain during PPV following topical lidocaine jelly and sub-Tenon anesthesia versus peribulbar anesthesia only.

Methods

Prospective, single-center, randomized study in which patients who needed PPV for macular hole (MH) or epiretinal membrane (ERM) at the Retina and Vitreous Section of the Department of Ophthalmology in a public hospital of São Paulo were invited to

participate. Patients were excluded if they were less than 18 years-old or had a history of PPV or scleral buckle surgery in the study eye, any previous ocular surgery in the study eye in the last 3 months, uncontrolled hypertension or any other medical or psychological condition that precluded the patient from performing the study procedures or provide informed consent. After providing verbal and written informed consent, patients were assigned to one of two groups at a ratio of 1:1 by simple randomisation. Patients and the main outcome measurer were masked for the study intervention. In Group ST, patients received topical anesthesia with 2% lidocaine jelly followed by sub-Tenon anesthesia with 2-4 ml of 10% ropivacaine. In Group PB, patients received peribulbar anesthesia only with 4-6 ml of 10% ropivacaine. After PPV, patients in both groups were asked to rate the level of pain they felt during the entire procedure (including anesthesia administration and PPV) by pointing at a 0-100 Visual Analogue Pain Scale (VAS). Data regarding demographics, patient characteristics and surgical aspects were also collected.

Sample size was calculated based on other studies [14, 17], considering a difference greater than 20 units in the mean pain score between groups to be significant, a standard deviation of 25 units, power of 90% and type I error of 5%. The estimated sample size was 60 patients (30 in each group).

Due to the difficulty in enrolling patients, we changed the original protocol inclusion criteria for patients who needed vitrectomy for complications of diabetic retinopathy, such as retinal detachment and vitreous hemorrhage, and chose not to include these patients, including only those who needed PPV for macular hole (MH) or epiretinal membrane (ERM).

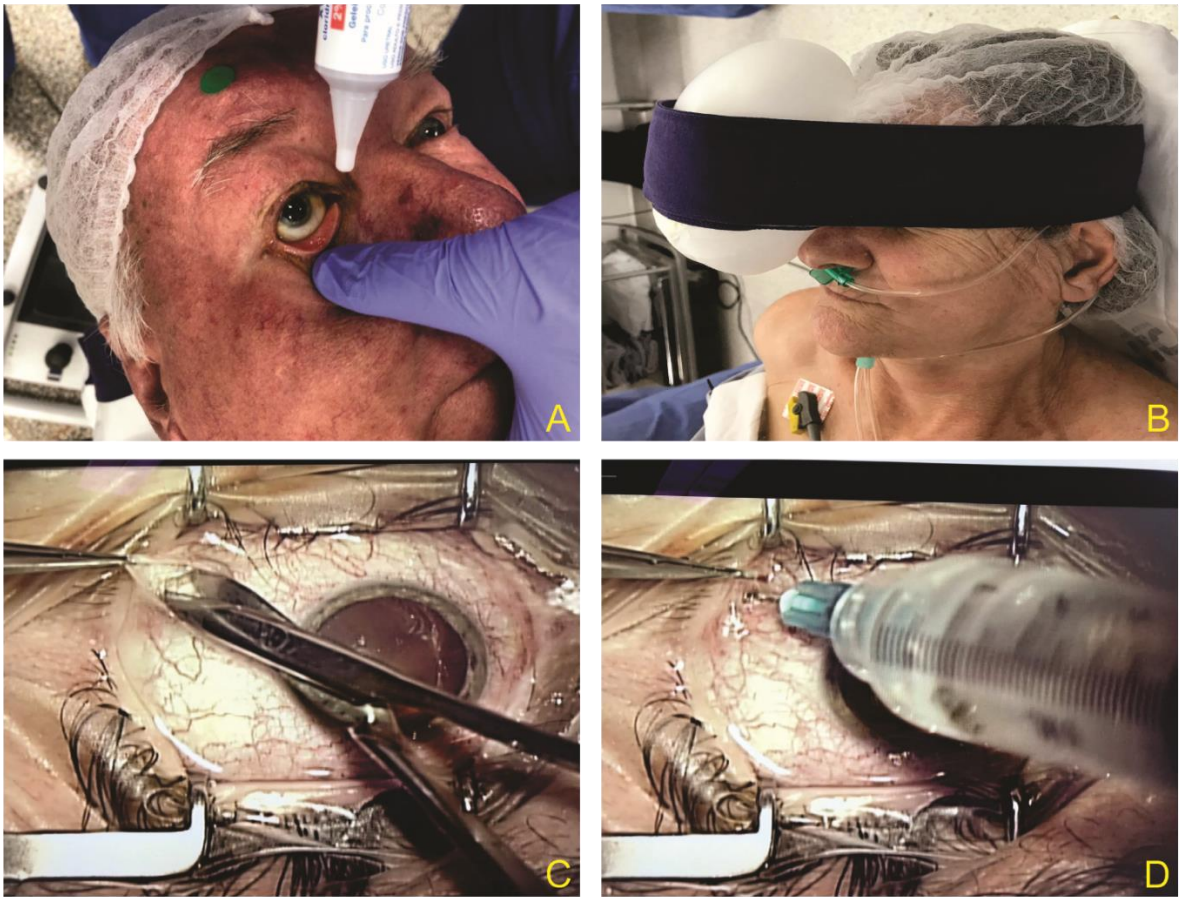
The study protocol (available as Supplementary material) adhered to the tenets of the Declaration of Helsinki and was approved by the local Institutional Review Board and registered in the ClinicalTrilas.gov under the number NCT03902925. All participants gave written informed consent before entering into the study.

Study procedures

During the preoperative evaluation, each patient received a detailed ophthalmologic examination including best-corrected visual acuity (BCVA) measurement according to the Early Treatment of Diabetic Retinopathy Study (ETDRS) standard refraction protocol, applanation tonometry, biomicroscopy of the anterior segment, indirect binocular ophthalmoscopy, red-free and color fundus pictures, and optical coherence tomography. The patients were then assigned randomly to one of the two groups:

Group ST: in the operating room, intravenous midazolam 5 ml (5 mg/ml) was administered by the anesthesiologist. Before draping, 2% lidocaine gel was applied to the superior and inferior conjunctival fornices of the study eye (Figure 1.A), and balloon compression was then applied for 5 minutes (Figure 1.B). Patients were subsequently prepared in an aseptic manner with sterile drape and blepharostat placement for sub-Tenon anesthetic injection, which was performed through a small incision in the conjunctiva and Tenon capsule 7-10 mm away from the corneal limbus in the inferotemporal quadrant (Figure 1.C). Anesthetic infiltration was performed using a metallic, curved, blunt cannula. Two to four ml of 10% ropivacaine were injected until fluid reflux was observed close to the limbus (Figure 1.D).

Fig 1. Group ST Anesthesia.



Group PB: in the operating room, intravenous midazolam 5 ml (5 mg/ml) was administered by the anesthesiologist. Before draping, 3-5 proximethacaine 5 mg/ml eyedrops (Anestalcon®) were placed on the conjunctiva and cornea of the study eye. After that but before draping, a peribulbar injection was performed under aseptic conditions in the operating room. Peribulbar injection was performed with a 30 x 0.7 mm 22G sharp needle in the temporal aspect of the inferior eyelid, using as a reference the transition from the middle to the outer third of the orbital rim. The needle was infiltrated parallel to the ocular globe toward the greater sphenoid wing. Four to six ml of 10% ropivacaine were injected until a drop of the upper eyelid was visualized. Balloon compression was then applied for 5 minutes. After that patients were subsequently prepared in an aseptic manner with sterile drape and blepharostat placement for vitrectomy.

The surgical procedure performed in both groups was a 23-gauge PPV which was combined with phacoemulsification and intraocular lens placement if significant lens

opacity was present. Pars plana vitrectomy was performed by one of two experienced retina surgeons and consisted of: 1) inferotemporal placement of a 23-gauge valved trocar and infusion line for balanced salt solution (Alcon, Texas, Fortworth) infusion; 2) superonasal and superotemporal placement of 23-gauge valved trocars; 3) PPV; 4) the posterior hyaloid was stained with triamcinolone acetonide and detachment of the posterior hyaloid was attempted in all patients without a pre-existing posterior vitreous detachment. In patients with a macular hole, brilliant blue dye was used to stain the internal limiting membrane, which was then peeled for 360-degrees around the hole; 5) endolaser photocoagulation was performed if needed for retinal breaks; 6) fluid-gas exchange and vitreous substitute placement was performed if indicated; and 7) removal of the 23-gauge trocars and injection of subconjunctival 4mg of dexamethasone.. A metal shield was placed over the operative eye, so that the pain examiner could not determine the type of anesthesia used in each case.

Evaluation of pain

Forty to sixty minutes after the end of the surgery, a masked examiner used a 100-point Visual Analog Scale (VAS) for pain score estimation [18]. The numbers of the scale were visible only on the examiner's side, so that patients could not choose the same number to guide pain ratings. Prior to rating level of pain, each patient was asked to slide the marker along the entire scale, with the aid of the examiner. At point 0, the examiner clarified to the patient that this point of the scale represented "no pain at all"; at point 100, the examiner clarified to the patient that this point of the scale represented "the most intense pain one could ever feel". The patient was asked about the intensity of pain during the whole procedure (anesthesia plus vitrectomy).

Statistical analysis

Group comparison of VAS score was performed with the Wilcoxon Rank-test. The Pearson test was used for nominal variables and a two-tailed t-Test was applied to the other comparisons between groups. All tests considered a significance level of $p < 0.05$. Software JMP 8.0.2 SAS Institute 2009 was used for statistical analysis.

Results

Fifty-four patients were included in the study (26 in the ST group and 28 in the PB group) between January 2019 and August 2019. One patient in the PB group was excluded due to the administration of morphine preoperatively and one patient in the ST group was excluded due to the need for combined glaucoma surgery (Figure 2). Baseline patient characteristics and surgical features of each group are summarized in Table 1. There were no significant differences between groups with respect to gender, age, presence of comorbidities (diabetes and arterial hypertension), surgical indication (MH or ERM), proportion of participants who underwent PPV versus combined phacoemulsification with intraocular lens implantation and PPV, proportion of participants who received endolaser, and duration of surgery.

Fig 2. CONSORT flowchart.

CONSORT
TRANSPARENT REPORTING of TRIALS

CONSORT 2010 Flow Diagram

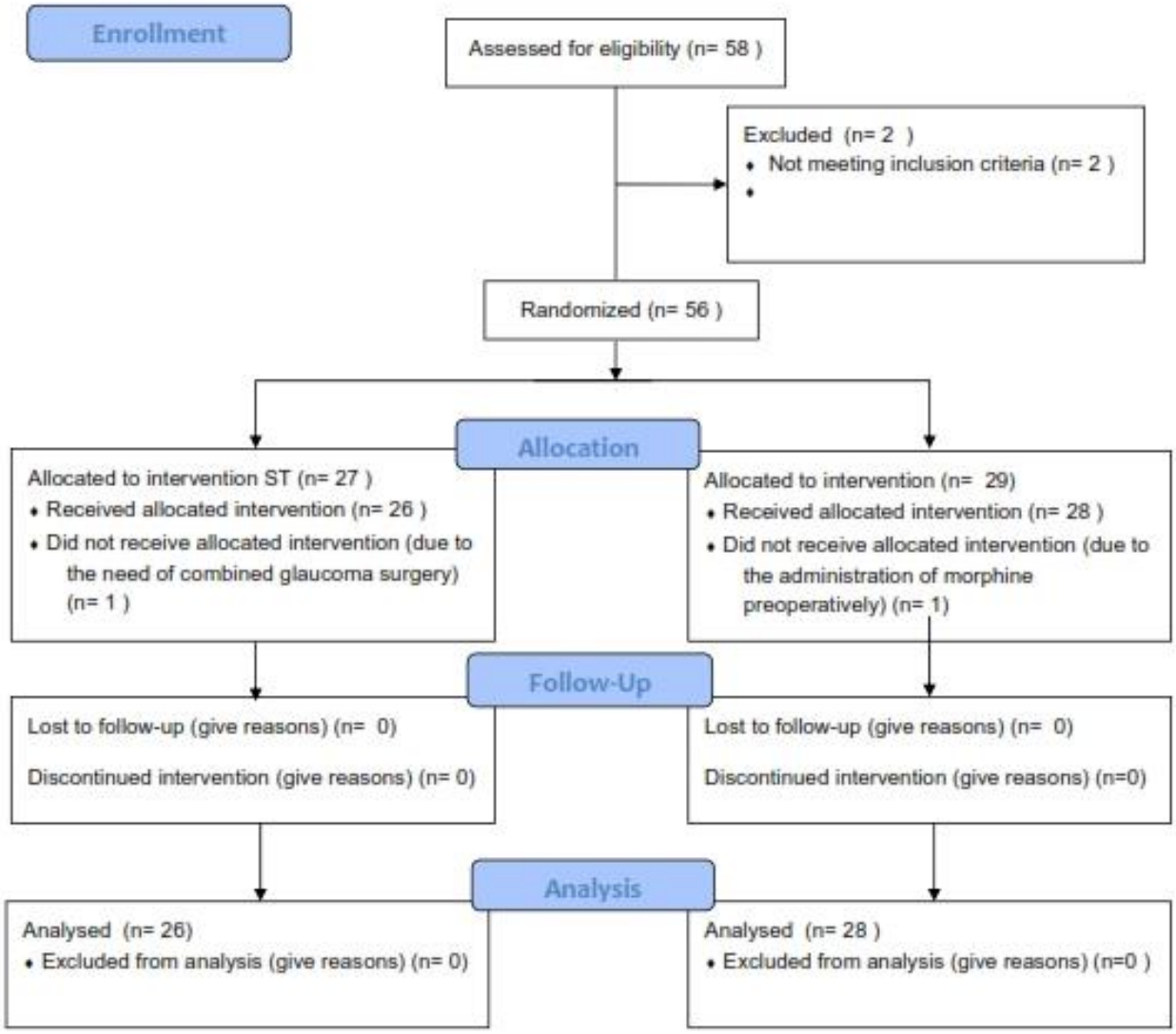


Table 1. Baseline participant characteristics and surgical features.

	ST	PB	p
Age (years, mean ± SD)	64 ± 6	63 ± 8	0.60**

	ST	PB	p
Male gender, N(%)	9(34.6%)	11(39.3%)	0.72***
Diabetes mellitus, N(%)	3(11.5%)	6(21.4%)	0.47*
Hypertension, N(%)	10(38.5%)	13(46.4%)	0.55***
Type of surgery Phaco + PPV : PPV, N(%)	16(61.5%):10(38.5%)	14(50%):14(50%)	0.39***
Endolaser photocoagulation, N(%)	6(23.1%)	5(17.9%)	0.63***
Duration of surgery (minutes, mean ± SD)	62 ± 12	70 ± 20	0.09**

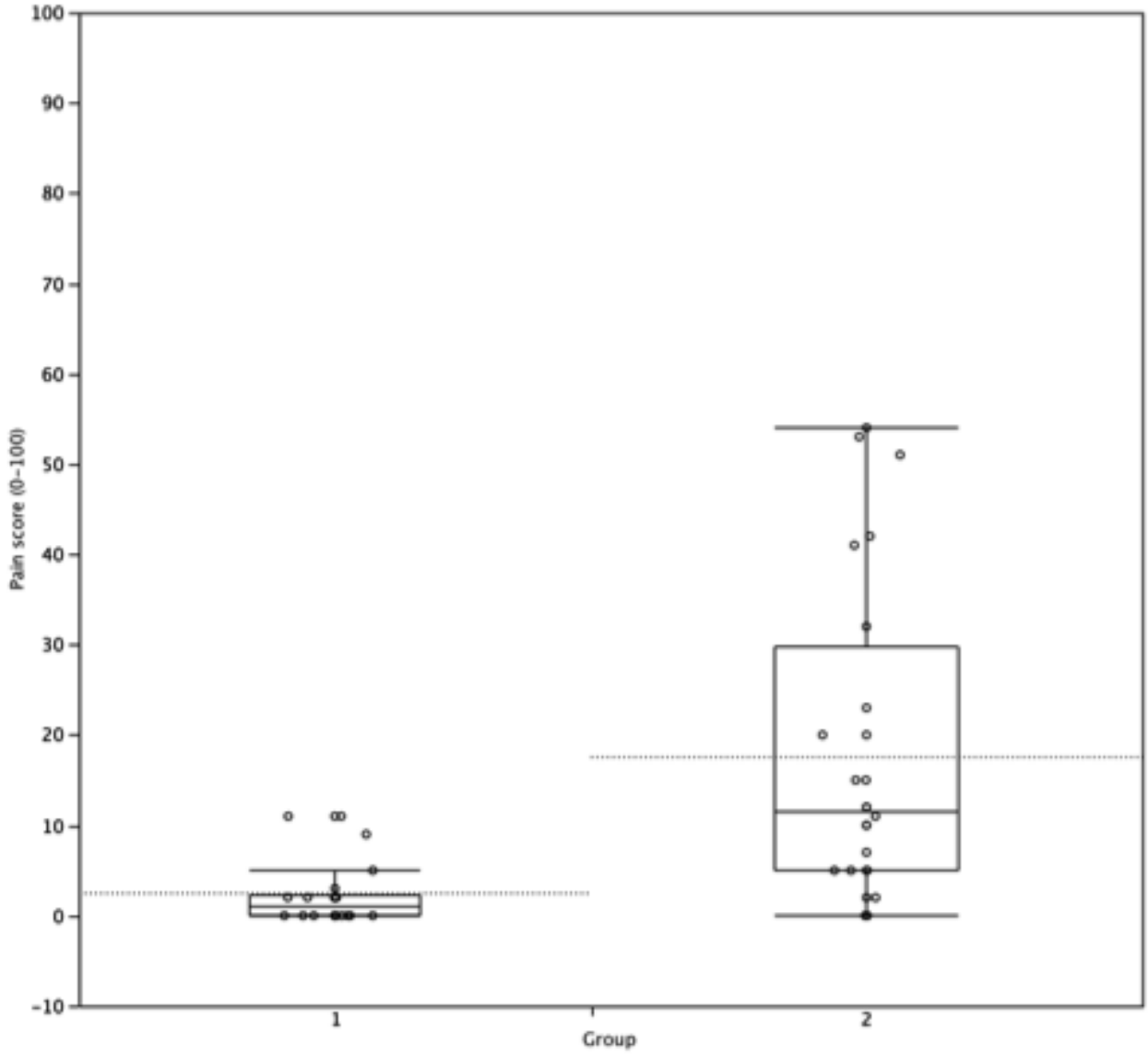
***Fisher's exact test; ** t Test; ***Likelihood Ratio; PPV= pars plana vitrectomy; phaco= phacoemulsification with intraocular lens implantation.**

No patient needed supplemental local or intravenous anesthesia intraoperatively, and no patient needed medication for controlling pain postoperatively. No sight- or life-threatening complication was observed in either group. In the ST group, the surgeon noted some patients lacked intraoperative akinesia and demonstrated some rapid eye movements during surgery, although this was not defined as main surgical complication and as such it was not accounted for.

Main outcome measure

Figure 3 shows the distribution of pain level ratings in both groups. The mean (±SEM) whole procedure pain was 2.4 ± 0.7 in the ST group compared to 17.5 ± 3.2 in the PB group ($p<0.0001$; Wilcoxon). Thirteen of the 26 patients from the ST group rated their pain level a zero, meaning they experienced no pain at all, and the maximum pain score was 11 (in 3 participants) with a median score of 1. In the PB group, only 2 of the 28 patients rated their pain level a zero, seven participants rated their pain level higher than 30, and the median pain level rating was 11.5.

Fig 3. Pain scores distribution in groups ST (1) and PB (2). (Dashed lines correspond to means; box plots including median and quantiles 25% and 75%)



Discussion

Based on a computerized search of the PubMed database, this is the first prospective study to compare pain during PPV following topical lidocaine jelly and sub-Tenon anesthesia versus peribulbar anesthesia only. Sub-Tenon anesthesia was more effective than peribulbar anesthesia for controlling pain during PPV. This may be due to superior effectiveness of the sub-Tenon mode of administration in delivering the anesthetic agent posteriorly to the globe, or perhaps a sub-Tenon injection preceded by topical

anesthesia is less painful than a peribulbar injection. Peribulbar anesthesia is also not precisely placed near its site of action, and the anesthetic solution should spread through the peribulbar tissue to obtain adequate analgesia and sometimes not reaching the retrobulbar space properly. Results of the current study are different from those reported in the literature regarding comparison of sub-Tenon versus retrobulbar anesthesia for vitrectomy surgery [14, 19], in which both techniques were equally effective.

In the current study, no patient needed supplemental local or intravenous anesthesia intraoperatively, and no patient needed medication for controlling pain postoperatively. In contrast, in the study of Lai et. al published in 2000 [14], supplemental anesthesia was required in 37% of patients who received sub-Tenon anesthesia, and 70% of patients required additional intravenous sedation for controlling pain, while a longer duration of surgery was recorded for both groups in this study compared to ours (mean ± SD, 96.6 ± 42.6 and 104.2 ± 54.8, for retrobulbar and sub-Tenon's capsule groups respectively) [14]. The difference between this study and ours may be due to the shorter duration of surgery and lack of scleral buckling and cryotherapy in our series.

Anesthesia-related adverse events were not observed in our study. The primary advantage of sub-Tenon over peribulbar and retrobulbar anesthesia is a more favorable safety profile [13, 14, 15, 19, 20, 21], since the use of a blunt cannula with sub-Tenon injections compared to a sharp needle with peribulbar and retrobulbar injections reduces the risks of such adverse events as globe perforation and retrobulbar hemorrhage. However, rare adverse events, including scleral perforation and retinal ischaemia, associated with sub-Tenon injection have been described, particularly in patients with previous ocular surgery, conjunctival scarring and thinned sclera [22, 23, 24, 25].

One potential limitation of the study was the administration of intravenous midazolam prior to sub-Tenon or peribulbar injection; however, this single dose of midazolam was provided to patients in both study groups and, therefore, cannot explain

the difference in pain level ratings between the groups. Another point to consider is that preoperative anxiety has been reported to be associated with intraoperative pain perception [26, 27], and the sub-Tenon approach may be associated with less anxiety than the retrobulbar approach since patients receiving sub-Tenon anesthesia do not see a needle moving toward them as is the case with peribulbar injections [13]. Another limitation of the current study is the fact that it included only patients undergoing PPV for MH or ERM; thus, the results of this study may not be applicable to patients undergoing PPV for other indications that require such surgical procedures as scleral buckling, cryotherapy or photocoagulation which are known to be associated with discomfort. Finally, the absence of akinesia associated with the sub-Tenon approach is a limitation of this technique.

Conclusion

In this study of patients undergoing PPV for MH or ERM, topical followed by sub-Tenon anesthesia was more effective in controlling pain during the whole vitrectomy procedure than peribulbar anesthesia. Compared to peribulbar anesthesia which is administered with a sharp needle, sub-Tenon anesthesia administered with a blunt cannula may be associated with a reduced risk of such adverse events as globe perforation, retrobulbar hemorrhage, and inadvertent injection of anesthesia into the optic nerve sheath. Further studies are necessary to confirm our preliminary findings.

References

1. Stead SW, Miller KM. Anesthesia for ophthalmic surgery. In: Spaeth GL, editor. Ophthalmic Surgery: principles and practice. 3rd edition. Philadelphia: Saunders; 2003. pp. 15-25.

2. Murat J, Chauvaud D.[Evaluation of a simplified protocol of local regional anesthesia for the surgery of the posterior segment]. J Fr Ophtalmol. 1993;16:254-258.

3. Charles S, Fanning GL. Anesthesia considerations for vitreoretinal surgery. Ophthalmol Clin North Am. 2006;19:239-243.

4. Costen MT, Newsom RS, Wainwright AC, Luff AJ, Canning CR. Expanding role of local anaesthesia in vitreoretinal surgery. Eye (Lond). 2005;19:755-761.

5. Knight HM, Newsom RB, Canning CR, Luff AJ, Wainwright AC. Local anaesthesia for vitreoretinal surgery: an audit of patient and surgical experience. Eur J Ophthalmol. 2001;11:366-371.

6. Newsom RS, Wainwright AC, Canning CR. Local anaesthesia for 1221 vitreoretinal procedures. Br J Ophthalmol. 2001;85:225-227.

7. Tognetto D, di Lauro MT, Fanni D, Zagidullina A, Michelone L, Ravalico G. Iatrogenic retinal traumas in ophthalmic surgery. Graefes Arch Clin Exp Ophthalmol. 2008;246:1361-1372.

8. Gillow JT, Aggarwal RK, Kirkby GR. Ocular perforation during peribulbar anaesthesia. Eye (Lond). 1996;10:533-536.

9. Edge R, Navon S. Scleral perforation during retrobulbar and peribulbar anesthesia: risk factors and outcome in 50,000 consecutive injections. J Cataract Refract Surg. 1999;25:1237-1244.

10. Tang S, Lai P, Lai M, Zou Y, Li J, Li S. Topical anesthesia in transconjunctival sutureless 25-gauge vitrectomy for macular-based disorders. Ophthalmologica. 2007;221:65-68.

11. Celiker H, Karabas L, Sahin O. A comparison of topical or retrobulbar anesthesia for 23-gauge posterior vitrectomy. J Ophthalmol. 2014;2014:237028. doi: 10.1155/2014/237028.

12. Bahçecioglu H, Unal M, Artunay O, Rasier R, Sarici A. Posterior vitrectomy under topical anesthesia. Can J Ophthalmol. 2007;42:272-277.

13. Li HK, Abouleish A, Grady J, Groeschel W, Gill KS. Sub-Tenon's injection for local anesthesia in posterior segment surgery. Ophthalmology. 2000;107:41-46.

14. Lai MM, Lai JC, Lee WH, Huang JJ, Patel S, Ying HS, et al. Comparison of retrobulbar and sub-Tenon's capsule injection of local anesthetic in vitreoretinal surgery. Arch Ophthalmol. 2000;118:1037-1043.

15. Mein CE, Woodcock MG. Local anesthesia for vitreoretinal surgery. Retina. 1990;10:47-49.

16. Bergman L, Berglin L, Algvere PV, Laurell CG, Stenkula S. Limbal sub-Tenon's administration of retrobulbar anesthesia using a blunt irrigating cannula. Ophthalmic Surg Lasers. 1996;27:106-112.

17. Bergman L, Bäckmark I, Ones H, von Euler C, Olivestedt G, Kvanta A, et al. Preoperative sub-Tenon's capsule injection of ropivacaine in conjunction with general anesthesia in retinal detachment surgery. Ophthalmology. 2007;114:2055-2060.

18. Cintra LP, Lucena LR, Da Silva JA, Costa RA, Scott IU, Jorge R. Comparative study of analgesic effectiveness using three different anesthetic techniques for intravitreal injection of bevacizumab. Ophthalmic Surg Lasers Imaging. 2009;40:13-18.

19. Reichstein DA, Warren CC, Han DP, Wirostko WJ. Local Anesthesia With Blunt Sub-Tenon's Cannula Versus Sharp Retrobulbar Needle for Vitreoretinal Surgery: A Retrospective, Comparative Study. Ophthalmic Surg Lasers Imaging Retina. 2016;47:55-59.

20. Davison M, Padroni S, Bunce C, Rüschen H. Sub-Tenon's anaesthesia versus topical anaesthesia for cataract surgery. Cochrane Database Syst Rev. 2007;18:CD006291. doi: 10.1002/14651858.CD006291.pub2

21. Kwok AK, Van Newkirk MR, Lam DS, Fan DS. Sub-Tenon's anesthesia in vitreoretinal surgery: a needleless technique. Retina. 1999;19:291-296.

22. Frieman BJ, Friedberg MA. Globe perforation associated with subtenon's anesthesia. Am J Ophthalmol. 2001;131:520-521.

23. Kumar CM, Eid H, Dodds C. Sub-Tenon's anaesthesia: complications and their prevention. Eye (Lond). 2011; 25:694–703.

24. Sohn HJ, Moon HS, Nam DH, Paik HJ. Effect of volume used in sub-Tenon's anesthesia on efficacy and intraocular pressure in vitreoretinal surgery. Ophthalmologica. 2008;222:414-421.

25. Feibel RM, Guyton DL. Transient central retinal artery occlusion after posterior sub-Tenon's anesthesia. J Cataract Refract Surg. 2003;29:1821-1824.

26. Segal O, Segal-Trivitz Y, Nemet AY, Cohen P, Geffen N, Mimouni M. Anxiety levels and perceived pain intensity during intravitreal injections. Acta Ophthalmol. 2016;94:203-204.

27. Socea SD, Abualhasan H, Magen O, Zayit-Soudry S, Blumenthal EZ, Duvdevan N, et al. Preoperative Anxiety Levels and Pain during Cataract Surgery. Curr Eye Res. 2019 Sep 18:1-6. doi:10.1080/02713683.2019.1666996. [Epub ahead of print]