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Cent. Eur. J. Med. • 4(1) • 2009 • 84-90
DOI: 10.2478/s11536-008-0039-5

Central European Journal of **Medicine**

Comparision of the effects of subtenon's and subconjunctival anesthesia on retroorbital hemodynamics

Research Article

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Received 28 March 2008; Accepted 5 May 2008

Abstract: The aim of the study was to compare retroorbital blood flow hemodynamics between subconjunctival and sub-Tenon's anesthesia. This was a prospective, blinded study and included 80 cases. Patients were monitored and treated in the First Ophthalmology Clinic, Ataturk Training and Research Hospital, Turkey. Sub-Tenon's anesthesia was performed in 42 cases, and subconjunctival anesthesia was performed in 38 cases. Color Doppler imaging to measure ocular blood flow parameters was performed preoperatively and 21 days after cataract operation in each case. Preoperative and postoperative values of resistivity and pulsatility indices in the ophthalmic, central retinal, and short posterior ciliary arteries were compared. Postoperative mean blood flow velocity measurements of ophthalmic artery were not statistically different between the subconjunctival anesthesia group and the sub-Tenon's anesthesia group (49.63 ± 14.00 vs. 45.85 ± 13.41; P=0.389). Postoperative RI values were higher in the Subtenon's anesthesia group than in the subconjunctival anesthesia group, but the difference between two groups was not statistically significant (0.81 ± 0.14 vs. 0.74 ± 0.08; P=0.079). The postoperative pulsatility index of the ophthalmic artery, RI of ophthalmic artery, pulsatility index of the central retinal artery, RI of the central retinal artery, and pulsatility index of the posterior ciliary arteries were not significantly different between the subconjunctival and sub-Tenon's anesthesia groups. In conclusion, the study suggests that postoperative retroorbital blood flow hemodynamics are the same following sub-Tenon's and subconjunctival anesthesia.

Keywords: *Color Doppler imaging • Cataract surgery • Subconjunctival • Sub-Tenon's • Anesthesia*

Abbreviations

PSV - peak-systolic velocity,
EDV - end-diastolic velocity,
MV - mean velocity,
PI - pulsatility index,
RI - RI-Resistivity index,
CDI - color Doppler imaging.

1. Introduction

The use of sharp needles for peribulbar and retroorbital anesthesia is well known to carry a risk for damage to the globe. Such damage can cause permanent damage when it does occur [1–3]. Despite this risk and alternative techniques such as subconjunctival, topical, and intracameral anesthesia are reported, peribulbar and retroorbital anesthesia are still preferred for uncooperative patients and challenging cases.

Sub-Tenon's block, described in 1992 by Stevens [4], has potential advantages over other anesthetic techniques in eye surgery and has since become a widely used technique. Because sub-Tenon's anesthesia

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Table 1. Demographic data of cases in subconjunctival anesthesia and sub-Tenon's anesthesia groups.

	Subconjunctival anesthesia	sub-Tenon's anesthesia	*P*-value
Number of cases	42	38	-
Mean age (years; mean ± standard deviation)	69.8 ± 9.3	72.2 ± 5.2	0.894
Male/female ratio	16/26	16/22	0.796

lacks the inherent risks of retroorbital anesthesia while providing a good level of akinesia, it is considered a good alternative to retroorbital anesthesia.

Ongoing studies are exploring the effects of different local anesthetic procedures, local anesthetics, and drug supplements on ocular blood flow. Although it was reported that the pulsatile ocular blood flow is markedly decreased after retroorbital anesthesia [5] and that the recovery of the pulsatile ocular blood flow after retroorbital anesthesia is very slow [6], subconjunctival anesthesia is not reported to significantly effect pulsatile ocular blood flow [7]. The effects of sub-Tenon's anesthesia on retroorbital blood flow has not been described, but several reports have shown effects of retroorbital anesthesia in the early postoperative period. Whether this causes short-term or more permanent changes remains unknown.

Color Doppler imaging (CDI) is a noninvasive ultrasound technique that can be used to determine flow velocities in retroorbital blood vessels and downstream vascular resistance. A variety of occlusive eye and orbit diseases have been examined by CDI [8-11]. In the current study, we used color Doppler imaging (CDI) to compare the effects of subconjunctival and sub-Tenon's anesthesia on retroorbital hemodynamics three weeks after cataract operation.

2. Materials and Methods

This was a prospective, blinded study. The study included 80 patients with cataracts that were monitored and treated in the First Ophthalmology Clinic, Ataturk Training and Research Hospital, Turkey. This study was approved by the institution's ethical committee. The research followed the tenets of the Declaration of Helsinki. Written informed consent was obtained from each participant before study initiation. Demographic and clinical data for the patients are summarized in Table 1.

All patients were examined by the following: visual acuity tests; biomicroscopy of the anterior segment; applanation tonometry to measure the intraocular pressure; gonioscopy; and funduscopy after dilation of the pupils with cyclopentolate hydrochloride 1% (Sikloplejin®; Abdi Ibrahim Inc., Istanbul, Turkey) and phenylephrine hydrochloride 2.5% (Mydfrin®, Alcon Laboratoires Inc, Fort Worth, Texas, USA) using a Goldmann three-mirror contact lens. Previous or current history of any topical or systemic drug use was recorded as was the presence of any systemic diseases. Exclusion criteria were the following: eye diseases other than cataracts; diabetes mellitus or any other systemic and/or cardiovascular diseases; a history of transient ischemic attacks or stroke.

Color Doppler imaging (CDI; Eccocee®; Toshiba, Tokyo, Japan) was performed using a 7.5-MHz linear transducer. All examinations were carried out while the patients were in the supine position with their eyes closed. CDI was carried out using acoustic gel. CDI of the optic nerve, which provides the most useful landmark for the identification of the retroorbital vessels, was performed. The ophthalmic artery is located above or below the optic nerve in the posterior orbit and extends forward into the nasal orbit in a horizontal plane slightly superior to that of the optic nerve. These vessels were examined approximately 25 mm behind the globe in the nasal orbit when the vessels were in a straight position, which provides the most reliable results. The central retinal artery could be detected approximately 10 mm behind the retrolaminar portion of the optic nerve, where it followed at straight path. The short posterior ciliary arteries begin as trunks approximately 10 to 20 mm behind the globe, before forming multiple branches surrounding the retroorbital portion of the optic nerve. This was chosen as the most appropriate site for CDI, allowing the nasal and temporal short posterior ciliary arteries to be identified and verified.

For each artery, the peak-systolic velocity (PSV) and end-diastolic velocity (EDV) were calculated from the color Doppler signals. The PSV was defined as the highest velocity of blood flow during the systolic phase of the cardiac cycle, and the EDV was defined as the velocity of blood flow at the end of the diastolic phase of the cardiac cycle. The mean blood flow velocity (MV) was defined as the average velocity of blood flow throughout the cardiac cycle. The pulsatility index (PI) and resistivity index (RI) were calculated for each examined eye and were calculated as follows: PI = [PSV-EDV]/MV and RI = [PSV-EDV]/PSV. Because MV measurements significantly vary for small-diameter vessels, only RI and PI were evaluated for central retinal and posterior ciliary arteries. Ultrasonographic evaluation was performed by a radiologist (A.A.) who was masked to the clinical diagnoses.

Table 2. Preoperative MV, RI, and pulsatility indices.

	Subconjunctival anesthesia	sub-Tenon's anesthesia	*P*-value
Ophthalmic artery			
Pulsatility index	1.64 ± 0.41	1.77 ± 0.47	0.364
RI	0.76 ± 0.09	0.78 ± 0.09	0.506
MV (cm/s)	55.36 ± 21.23	47.52 ± 17.90	0.212
Central retinal artery			
Pulsatility index	1.87 ± 0.57	1.93 ± 0.62	0.733
RI	0.80 ± 0.10	0.82 ± 0.11	0.491
Posterior ciliary artery			
Pulsatility index	1.58 ± 0.48	1.76 ± 0.52	0.258
RI	0.75 ± 0.11	0.77 ± 0.12	0.560

Values are means ± standard deviation.

Table 3. Postoperative MV, RI, and pulsatility indices.

	Subconjunctival anesthesia	sub-Tenon's anesthesia	*P*-value
Ophthalmic artery			
Pulsatility index	1.72 ± 0.57	1.63 ± 0.41	0.568
Resistivity index	0.76 ± 0.09	0.76 ± 0.08	0.842
MV (cm/s)	49.63 ± 14.00	45.85 ± 13.41	0.389
Central retinal artery			
Pulsatility index	1.96 ± 0.60	2.05 ± 0.63	0.579
Resistivity index	0.80 ± 0.09	0.83 ± 0.08	0.314
Posterior ciliary artery			
Pulsatility index	1.56 ± 0.49	1.68 ± 0.46	0.417
Resistivity index	0.74 ± 0.08	0.81 ± 0.14	0.079

Values are means ± standard deviation.

Sub-Tenon's anesthesia was performed for in cases in group I. After placement of a Kratz-Barraquer lid speculum, the conjunctiva was cleaned with 4% povidone iodine. The fused conjunctiva and anterior Tenon capsule was picked up at an inferonasal point 7 to 10 mm from the limbus, midway between the insertions of the medial and inferior rectus muscles, and the sub-Tenon's space was accessed using blunt Westcott scissors to create a thin channel to the posterior region of sub-Tenon's space. A blunt-tipped sub-Tenon's cannula was then inserted into the posterior sub-Tenon's space, and approximately 2.5 ml of 2% lidocaine hydrochloride (Jetocaine®; Adeka Inc, Samsun, Turkey) was introduced.

Subconjunctival anesthesia was performed for cases in group II. At the beginning of surgery, 0.5 ml of 2% lidocaine hydrochloride (Jetocaine®) was injected in the subconjunctival area just behind limbus in the superonasal and superotemporal quadrants.

All cataract operations were performed by the same surgeon. A 3.2-mm wide clear corneal tunnel incision was made. After phacoemulsification, a flexible intraocular lens (IOL) (OcuFlex®; Polymer Technologies Int. EOU, Gujarat, India) was implanted in the capsular bag. The sodium hyaluronate (Cohaerens®; LCA Pharmaceutical, Chartres, France) was then thoroughly removed by aspiration. Postoperative treatment consisted of prednisolone acetate (Predforte®) and oflaxocin 0.3% (Exocin®; Westport Co, Mayo, Ireland) eye drops four times daily. Postoperative CDI was repeated 21 days after the operation.

Results are expressed as means ± standard deviation. Continuous data were analyzed using Student's *t*-test for independent variables. Categorical data were analyzed by a chi-square test. A *P*-value of less than 0.05 was considered as indicating a statistically significant difference. All statistical analyses were performed using the NCSS statistical package.

3. Results

In this study, 42 cataract patients received sub-Tenon's anesthesia and 38 received subconjunctival anesthesia. Demographic data are shown in Table 1. The mean ages were not statistically different (72.2 ± 5.2 vs. 69.8 ± 9.3 years, respectively; *P*=0.894). The male/female ratios

Table 4. Comparison of postoperative and preoperative MV, RI, and pulsatility indices.

	Preoperative	Postoperative	*P*-value
Ophthalmic artery			
Pulsatility index	1.64 ± 0.41	1.72 ± 0.57	0.489
Resistivity index	0.76 ± 0.09	0.76 ± 0.09	0.761
MV (cm/s)	55.36 ± 21.23	49.63 ± 14.00	0.260
Central retinal artery			
Pulsatility index	1.87 ± 0.57	1.96 ± 0.60	0.551
Resistivity index	0.80 ± 0.10	0.80 ± 0.09	0.950
Posterior ciliary artery			
Pulsatility index	1.58 ± 0.48	1.56 ± 0.49	0.898
Resistivity index	0.75 ± 0.11	0.74 ± 0.08	0.722

Values are means ± standard deviation.

Table 5. Postoperative and preoperative mean MV, RI, and pulsatility indices.

	Preoperative	Postoperative	*P*-value
Ophthalmic artery			
Pulsatility index	1,72 ± 0,57	1.63 ± 0.41	0,103
Resistivity index	0.76 ± 0.09	0.76 ± 0.08	0,391
MV (cm/s)	49.63 ± 14.00	45.85 ± 13.41	0,550
Central retinal artery			
Pulsatility index	1.96 ± 0.60	2.05 ± 0.63	0,366
Resistivity index	0.80 ± 0.09	0.83 ± 0.08	0,862
Posterior ciliary artery			
Pulsatility index	1.56 ± 0.49	1.68 ± 0.46	0,496
Resistivity index	0.74 ± 0.08	0.81 ± 0.14	0,369

were also not statistically different (16/22 vs. 16/26; *P*=0.796).

Preoperative parameters determined by CDI (MV, PI, and RI) were not statistically different between the two groups (Table 2). Also, postoperative MV values for the ophthalmic artery were not statistically different between the subconjunctival and Sub-Tenon's anesthesia groups (49.63 ± 14.00 vs. 45.85 ± 13.41 cm/s; *P*=0.389). Although postoperative RIs were higher in sub-Tenon's anesthesia group than in the subconjunctival anesthesia group (0.81 ± 0.14 vs. 0.74 ± 0.08), the difference was not statistically significant (*P*=0.079). There were no significant differences in postoperative PI or RI for the ophthalmic artery, PI or RI for the central retinal artery, or PI of the posterior ciliary arteries (Table 3). In addition, there were no significant differences in any of the pre- and post-operative parameters for patients treated with subconjunctival anesthesia (Table 4). For patients receiving sub-Tenon's anesthesia, pre- and post-operative CDI measurements similar and there were no significant difference in pre- and post-operative values (Table 5).

4. Discussion

In this study, we compared the retroorbital hemodynamics in cataract patients receiving subconjunctival and sub-Tenon's anesthesia as measured by CDI. Pre- and post-operative CDI measurements between the two groups were not statistically different.

Anesthetic agents and other drugs can have local effects on choroidal and retinal blood flow. During cataract surgery using retroorbital or general anesthesia, the pulsatile ocular blood flow as measured with the Langham pneumotonometer appears to decrease [12]. In addition, a decrease in ocular blood flow and an increase in intraocular pressure have been detected by oculo-oscillo-dynamography during retroorbital and peribulbar anesthesia [13-15].

Hulbert *et al*. [5] found a marked decrease in pulsatile ocular blood flow after retroorbital anesthesia with and without epinephrine. Also, Meyer *et al*. [16] demonstrated that in porcine ciliary arteries, local anesthesia impairs endothelial formation of nitric oxide from L-arginine after stimulation with bradykinin, which may contribute substantially to a reduction in blood flow to the eye during retroorbital anesthesia. Also mechanical compression of retroorbital tissue space [17] due to a negative effect of local anesthetics on autoregulation [18] has been reported to decrease pulsatile ocular blood flow after retroorbital anesthesia.

On the other hand, during subconjunctival anesthesia, retroorbital vessels are not compressed and there are no changes in intraocular pressure. Thus, there many be little diffusion of local anesthetics into the retroorbital vessels [19]. In other words, diffusion of local anesthetics might be too slow or the amount of drug reaching the retroorbital space may be too low to affect retroorbital hemodynamics [20]. Our findings indicate that the effects of sub-Tenon's and subconjunctival anesthesia on retroorbital hemodynamics are not significantly different.

The presence of cataracts also effects retroorbital blood flow. Grieshaber *et al*. [21] reported that reduced local blood flow velocity in the ophthalmic artery appears to be associated with the presence of cataracts. They also reported that even when age-matched groups were considered, even when smokers were excluded, ocular blood flow was reduced in cataract patients. Using an ocular blood flow tonograph, Spraul *et al*. [22] found a decrease in pulsatile ocular blood flow on the third day after cataract surgery. The authors speculated that there was a neural mechanism triggered by cataract extraction that causes this temporary decrease in ocular blood flow.

In principle, several factors could account for a change in ocular blood flow after cataract surgery. For example, a postoperative increase in intraocular pressure may occur, especially in the first 24 h after operation [23-25]. This may lead to a concomitant decrease in ocular perfusion pressure. However, there is evidence that retinal vessels autoregulate over a wide range of perfusion pressures, and recent studies indicate that the human choroid has some potential for autoregulation in response to a decrease in ocular perfusion pressure [26-27].

Intraocular pressure increases that reduce the ocular perfusion pressure beyond the lower level of autoregulation should cause a decrease in ocular blood flow. In patients with compromised autoregulation, this problem may be worsened. Other factors that may influence ocular blood flow during cataract surgery included changes in blood pressure, posture, venous return, carbon dioxide levels, and the local anesthetics used. These factors may be more relevant for patients with compromised ocular blood flow regulation.

Our study has showed that there are no differences in the effects of sub-Tenon's and sunconjunctival anesthesia on retroorbital hemodynamics. On the basis of previous studies, we expected that subconjunctival anesthesia would not have a major adverse effect on retroorbital hemodynamics. Our results suggest that sub-Tenon's anesthesia should also be safe and might be preferred when good akinesia is required.

The lack of a significant effect of sub-Tenon's anesthesia on retroorbital blood flow may be due to a lack of diffusion of anesthetic.

Currently, routine cataract extraction is done mostly under topical or combined topical and intracameral anesthesia. On the other hand, topical or combined topical and intracameral anesthesia may not be sufficient in challenging cases such as for patients with dementia, hearing loss or other difficult cases. Sub-Tenon's anesthesia might be preferred in such cases.

Several factors influence orbital blood flow measurement with CDI, including age, systemic blood pressure, blood viscosity, and stenosis of the carotid artery [28-29]. Orbital blood flow velocities are also affected by increased intraocular pressure. Trible et al. [30] demonstrated increased blood flow velocity and decreased RI in patients with glaucoma after they had undergone trabeculectomy. However, recent studies have shown that an artificially increased intraocular pressure affects the hemodynamics of the short posterior ciliary artery and central retinal artery, while leaving the hemodynamics of the ophthalmic artery intact [31-32].

Orbital blood flow velocity measurements vary depending on the measurement angle. On the other hand, the PI and RI give more reliable information about the vascular flow pattern. The RI is an indirect indicator of blood flow velocity. The MV is an important parameter in the calculation of the RI. An increase in resistance in the vasculature strongly affects the MV and EDV. Both the RI and PI are reliable indices for evaluation of end organ resistance. The RI is an indicator of end organ resistance to blood flow, but the PI is more affected by changes in vessel elasticity and systemic blood pressure. In our study, for evaluation of blood flow in small vessels such as the central retinal and posterior ciliary arteries, we only used the PI and RI, which should have reduced the possibility of a bias due to variability in measurements.

In our study, we made postoperative CDI measurements 21 days after surgery. Our main aim was to study the effects of ocular anesthesia on retroorbital hemodynamics after the short-term effects of cataract surgery had disappeared. Several reports have shown effects of retroorbital anesthesia in the early postoperative period, but the key question of whether these short-term effects are transient or cause permanent alterations was not addressed. We attempted to answer this question in this study. We found that subconjunctival and sub-

Tenon's anesthesia had similar effects on retroorbital hemodynamics when measured 21 days after surgery.

In conclusion, although further studies are needed, we found that the retroorbital hemodynamics in the late postoperative period do not differ between sub-Tenon's and subconjunctival anesthesia. Thus, sub-Tenon's anesthesia may be an option for anesthesia in cataract surgery without a significant risk for disruption of ocular blood flow.

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