Diabetic Retinopathy and its Impact on Ocular Hemodynamics during Local Anesthesia Comparing Peribulbar and Subtenon in Phacoemulsification

ASHRAF R. ASSWA, M.D.*; SAMY ELSAYEH, M.D.**; MOHAMMED YOSRY, M.D.***; MOHAMED EL-MALT, M.D.** and OMNEYA FOUAD, M.Sc.**

The Departments of Anesthesiology and Ophthalmology, Faculty of Medicine*, Cairo University and Research Institute of Ophthalmology**

Abstract

Background: The changes in intraocular pressure (IOP) during anesthesia and different anesthetic techniques which affect the retinal blood flow especially in affected impaired retinal perfusion as in diabetes.

Aim of the Work: To compare the efficacy of subtenon with peribulbar local anesthesia in diabetic retinopathy patient undergoing cataract surgery as they had compromised retinal perfusion who may had damaged optic disc any transient increase in intraocular pressure or reduction in retinal blood flow may lead to loss of remaining central vision. The effect of Regional anesthesia on retinal blood flow had not been studied before in diabetic retinopathy patients.

Study Design: A randomized controlled trial.

Methodology: Eighty patients included in this study were randomly assigned to one of 4 groups divided into 2 groups receiving subtenon block and other 2 groups receiving peribulbar block. Peak systolic velocity was measured immediately before the block, after 1 minute and after 10 minutes of injection of the local anesthetic. Also, IOP, the other parameters measured by the color Doppler imaging including end diastolic velocity, mean vascular pressure, pulsatility index and resistivity index, and the incidence of complications were recorded.

Results: There was significant difference in drop of variants (PSV, EDV, MV, PI) which might put the eye in critical situation.

Conclusion: Subtenon anesthesia provides smaller reduction in retinal blood flow.

Key Words: Intraocular pressure – Diabetic retinopathy – Subtenon Block – Peribular block.

Introduction

ALTHOUGH central retinal artery occlusion after routine cataract surgery is unusual complication, yet it may lead to loss of vision lasting for many days, it is considered as one of the most deleterious complications [1].

Central retinal artery occlusion following peribulbar anesthesia had been documented [2], several mechanism can explain retinal ischemia [3], the high volume injected, the speed of injection, compression of ocular globe at high pressure for prolonged period of time, and vasoconstrictor effect of local anesthetic agents [4].

DM is one of the most common disease associated with cataract surgery.

There is reduction in retinal blood velocity in DM especially in diabetic retinopathy patient due to morphological changes in vascular bed [5].

Retinal damage is caused by both microvascular leak-age from break down of inner blood retinal barrier and microvascular occlusion diabetic retinopathy can be classified into non proliferative diabetic retinopathyand proliferative diabetic retinopathy diabetic it progress in four stages.

• Mild nonproliferative: Small area of balloon like swelling in the retina

• Microanurysm.

• Moderate non proliferative the blood vessels swell and distorted.

• Severe nonproliferative retinopathy blood vessels are blocked.

The methods that are currently available for assessing ocular blood flow include fluorescein angiography, color Doppler imaging, laser Doppler velocimetry and pneumotonometry [6].
Pulsatile choroidal blood flow and retinal blood flow velocity were reduced after peribulbar. This support the theory of drug induced VC after peribulbar [7]. However the increase in IOP is responsible for changes in blood flow.

Regional block has been associated with ischemic complication such as central retinal vascular occlusion, optic atrophy ischemic optic neuropathy.

Color Doppler imaging provide information on blood velocity in ophthalmic, central retinal and short post ciliary artery by using B scan ultrasound [8].

Subtenon block or episcleral block is a safe alternative to the more commonly used peribulbar block, it has many advantages including the avoidance of globe perforation and optic nerve injury. It is also less painful and more safe in anticoagulated patients, long axial length and in patients with high IOP.

The effect of peribulbar or subtenon anesthesia on ocular blood flow in diabetic retinopathy patients had not been studied before.

We hypothesize that subtenon block will have more favourable effect on retinal blood flow in diabetic retinopathy patient.

The aim of this study was to assess the effect peribulbar in comparison to subtenon block on both the IOP and ocular blood flow in diabetic retinopathy patient comparing them with a control non diabetic cohort undergoing cataract surgery.

**Patients and Methods**

This study was conducted after approval of reasearch and ethical committee of reaserch institute of ophthalmology and after informed consent was taken from all patients participating in the study. The study had been done in 2013.

Eighty patients included in study were randomly assigned to one of 4 groups 2 groups receiving sub tenon block and other 2 groups receiving peribulber block.

The method of randomization used was closed envelop technique after generation of randomized numbers.

All patients included as AsA II physical status and type II DM controlled the age of the patients included in the study was between 40 and 70 years.

We excluded if the patients who were confused, unable to lie flat,have coagulopathy, high axial length, diabetic retinopathy, staphyloma and known allergic to local anesthetc used.

On arrival to OR an intravenous cannula was secured in all patients and premedication was given in the form of midazolam 0.04-0.07mg/kg.

Standard monitoring was applied to patients immediately before sedation and continued throughout the whole procedure with vital signs recorded every ten minutes.

IOP was measured using applanation tonometry method and RBF by color Doppler imaging, were taken followed by instillation of topical eye anestheisa by benoxinate 0.4% eye drop. The eye was then prepared for local anesthesia.

Retinal blood flow and intraocular pressure was measured 1 minute and 10 minutes after completion of local block.

Peripulbar anesthesia was performed by injecting 5ml of lidocaine and bupivacaine mixture (lidocaine 1%, and Bupivacaine 0.25% (to which a hyalurindase) 15 units/ml were added via a single inferotemporal injection.

Subtenon anesthesia was performed by instillation of benoxinate eye drops 0.4% and after 2 minutes an eye speculum inserted.

A small incision was made in the conjunctiva using Westcotts scissors. A visitec 19 guage Stevens’s cannula was carefully placed into the sub-tenon’s space. Using the same mixture and volume of local anesthetic solution as peribublar [9]. After the injection gentle orbital pressure was applied for two minutes and then eye movements were measured (No movement 1, mild movement 2 moderate 3 sever movement 4).

**Sample size:**

Using G*Power 3.1 application for sample size calculation and according to a previous study (Coskun et al.) which showed a reduction in the peak systolic velocity of the central retinal vein of 21.5% with a SD of 2.6 and assuming a 25% difference with a SD of 5cm/s, a sample size of 18 patients per study group was estimated to have at least an 80% power (a ≠ .05) to detect a 25% difference in the peak systolic velocity between groups. We included 20 patients in each group to allow for dropouts.
Statistical analysis:

Descriptive statistics were used to assess the clinical and demographic features of the patients. Data were presented as means (SD) numbers and per cents as appropriate. Also, 2 way ANOVA test was used to evaluate continuous variables. The Statistical Package for Social Sciences 16.0 (SPSS Inc, Chicago, Ill.) program was used for all statistical analyses, and a p-value less than 0.05 was considered statistically significant.

Results

This study included 80 patients (4 patients were excluded because of failure of the blocks, 3 in the peribulbar groups and 1 in the subtenon groups), 35 females and 45 males. The mean age was 46.2±7.1 years. Demographic and clinical characteristics of the patients are summarized in Table (1). The hemodynamic data of all groups are presented in Table (2). There was no significant difference among the four studied groups regarding these data.

In all studied groups, both PSV and EDV significantly decreased after the sub-Tenon and peribulbar injection. The drop was more prominent in the peribulbar groups A and B. However, no differences were observed in the change in RIs except for group C in which there was no change in the RI after subtenon injection. The hemodynamic changes in the retrobulbar vessels and the IOP are summarized in Table (2).

Table (1): Demographic data in the 4 studied group.

<table>
<thead>
<tr>
<th></th>
<th>A n (20)</th>
<th>B n (20)</th>
<th>C n (20)</th>
<th>D n (20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>49 (8)</td>
<td>50 (5.8)</td>
<td>47.2 (5.7)</td>
<td>50.2 (2.5)</td>
</tr>
<tr>
<td>Sex</td>
<td>9 M &amp; 11 F</td>
<td>14M &amp; 6F</td>
<td>13M &amp; 7F</td>
<td>13M &amp; 7F</td>
</tr>
<tr>
<td>ASA</td>
<td>1 (0.2)</td>
<td>2 (0.2)</td>
<td>1 (0.2)</td>
<td>2 (0.2)</td>
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<tr>
<td>Axial length</td>
<td>21</td>
<td>22</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>

Table (2): Hemodynamic data of all groups.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (T0)</td>
<td>125 (4)</td>
<td>130.2 (8.8)</td>
<td>138 (3.3)</td>
<td>138 (3.3)</td>
</tr>
<tr>
<td>SBP (T1)</td>
<td>140.7 (7.5)</td>
<td>136.3 (6.4)</td>
<td>142.3 (3.6)</td>
<td>142 (3.6)</td>
</tr>
<tr>
<td>DBP (T0)</td>
<td>72 (4.2)</td>
<td>71 (8)</td>
<td>70 (3)</td>
<td>72 (2.5)</td>
</tr>
<tr>
<td>DBP (T1)</td>
<td>72 (4.2)</td>
<td>73 (8.5)</td>
<td>72 (3.3)</td>
<td>73 (3)</td>
</tr>
<tr>
<td>Pulse (T0)</td>
<td>65.05 (2.8)</td>
<td>77</td>
<td>85.2 (3.6)</td>
<td>85.2 (3.6)</td>
</tr>
<tr>
<td>Pulse (T1)</td>
<td>84.05 (0.7)</td>
<td>89 (4.5)</td>
<td>93.2 (3.5)</td>
<td>93.2 (3.5)</td>
</tr>
<tr>
<td>Glycosylated Hb</td>
<td>6.75 (0.4)</td>
<td>6.9 (0.3)</td>
<td>7.0 (0.3)</td>
<td>7.0 (0.3)</td>
</tr>
</tbody>
</table>

Table (3): Measurements ocular hemodynamic and pressure changes in the 4 studied groups.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV Before</td>
<td>21.6 (2.3)</td>
<td>15.9 (0.6)</td>
<td>22.19 (3)</td>
<td>14.99 (1.1)</td>
</tr>
<tr>
<td>I min</td>
<td>17.4 (2.1)*</td>
<td>13.6 (1.1)*</td>
<td>20.6 (3)*</td>
<td>12.95 (1.4)*</td>
</tr>
<tr>
<td>10min</td>
<td>20.5 (1.1)*</td>
<td>14.3 (0.9)*</td>
<td>21.7 (2.9)*</td>
<td>14.25 (1.1)*</td>
</tr>
<tr>
<td>EDV Before</td>
<td>4.37 (0.96)</td>
<td>6.4 (0.81)</td>
<td>6.24 (1.11)</td>
<td>6.69 (0.59)</td>
</tr>
<tr>
<td>I min</td>
<td>2.62 (0.9)*</td>
<td>5.4 (1.04)*</td>
<td>5.37 (1.12)</td>
<td>6.04 (0.61)*</td>
</tr>
<tr>
<td>10min</td>
<td>4.05 (1.2)*</td>
<td>5.8 (0.89)*</td>
<td>5.92 (1.14)*</td>
<td>6.4 (0.6)*</td>
</tr>
<tr>
<td>MV Before</td>
<td>8.6 (1.1)</td>
<td>7.5 (0.7)</td>
<td>8.7 (0.88)</td>
<td>7.42 (0.61)</td>
</tr>
<tr>
<td>I min</td>
<td>7.1 (1.1)*</td>
<td>5.6 (2.08)*</td>
<td>8.1 (0.86)*</td>
<td>6.41 (0.62)*</td>
</tr>
<tr>
<td>10min</td>
<td>8.2 (1.1)*</td>
<td>6.78 (0.7)*</td>
<td>8.5 (0.89)*</td>
<td>7.08 (0.65)*</td>
</tr>
<tr>
<td>PI Before</td>
<td>1.24 (0.13)</td>
<td>0.99 (0.18)</td>
<td>1.35 (0.15)</td>
<td>0.83 (0.13)</td>
</tr>
<tr>
<td>I min</td>
<td>0.84 (0.13)</td>
<td>0.43 (0.22)*</td>
<td>1.09 (0.15)*</td>
<td>0.43 (0.13)*</td>
</tr>
<tr>
<td>10min</td>
<td>0.95 (0.13)</td>
<td>0.57 (0.2)*</td>
<td>1.28 (0.16)*</td>
<td>0.53 (0.13)*</td>
</tr>
<tr>
<td>RI Before</td>
<td>0.52 (0.04)*</td>
<td>0.76 (0.1)</td>
<td>0.57 (0.05)</td>
<td>0.76 (0.08)</td>
</tr>
<tr>
<td>I min</td>
<td>0.81 (0.04)*</td>
<td>1.23 (0.1)*</td>
<td>0.67 (0.05)*</td>
<td>1.07 (0.1)*</td>
</tr>
<tr>
<td>10min</td>
<td>0.52 (0.04)*</td>
<td>0.77 (0.1)*</td>
<td>0.57 (0.05)*</td>
<td>0.76 (0.08)*</td>
</tr>
<tr>
<td>IOPBefore</td>
<td>12.45 (0.6)</td>
<td>14.5 (0.5)</td>
<td>14.5 (0.51)</td>
<td>14.5 (0.5)</td>
</tr>
<tr>
<td>I min</td>
<td>15.45 (0.6)*</td>
<td>19.5 (0.5)*</td>
<td>17.5 (0.51)</td>
<td>17.5 (0.5)*</td>
</tr>
<tr>
<td>10min</td>
<td>12.45 (0.6)*</td>
<td>14.5 (0.5)*</td>
<td>14.5 (0.51)</td>
<td>14.5 (0.5)*</td>
</tr>
<tr>
<td>Akinesia score</td>
<td>2 (0.4)</td>
<td>3 (0.2)</td>
<td>1 (0.44)</td>
<td>1.8 (0.58)</td>
</tr>
</tbody>
</table>

* Indicates p-value <0.05.

PSV : Peak systolic Velocity.
EDV : End Diastolic Velocity.
MV : Mean Velocity.
RI : Resistance Index.
IOP : Intra Ocular Pressure.

Discussion

Peribulbar anesthesia is known to be safer but it still has the tendency to cause damage to optic nerve through the remote effects of anesthetic agent, amount injected, speed of injection and the use of post injection mechanical compression.

The possible mechanisms are due to increase IOP secondary to globe compression by anesthetic agents or due to vasoconstrictor effect of anesthetic agents.

Our study showed that the pulsatile index was marked reduced in diabetic retinopathy patients more the control group.

Also the peak systolic velocity was statistically significant reduced in diabetic retinopathy more than the control group. Regarding the EDV and the MV there was no significant effect in patients receiving peribulbar anesthesia.

Regarding the subtenon block the MV, PSV, EDV, PI didn’t show statistically significant change.

In diabetic retinopathy patients there is reduction in blood flow velocity compared with healthy control patients supporting the abnormal vessel function in eye with non proliferative diabetes [10].
Our results are in accordance with earlier studies investigating the effects of peribulbar anesthesia on ocular hemodynamic, the study of Findl et al., in 1999 [5] showed reduction in PoBF 15% and Retinal BL flow velocity after peribulbar block.

This reduction remained for five minutes after anesthesia despite the returning of IOP to that base line values. Supporting the theory of drug induced VC after peribulbar blocks.

In his study the researcher used total volume of 5ml of anesthetic mixture consist of 2.5ml of lidocaine 2%, 2.5ml bupivacaine 5% and hyaluronidase 150IU/ml. Injected in infero-temporal quadrant.

In our study we used similar volume but the hyaluronidase concentration in our anesthetic mixture was much less (15IU/ml). Also, the reduction in the pulsatile blood flow and velocity in the study by Findl and his colleagues was around 15% of the baseline values while in our study the reduction was around 30% of the baseline values. Regarding the resistive index. In their study there was an increase in resistivity of around 4% of the baseline, while in our study the increase in the RI after 1min (60% rise) but returned nearly to baseline after 10 minutes. Using high dose of hyaluronidase is unsafe and cause many side effects there is risk of allergic reaction as orbital redness and swelling.

Solveig et al., in 2006 [6] investigated the effect of volume of local anesthetic injected in peribulbar anesthesia where they compared the effect of 2ml and 5ml local anesthetic mixtures. They concluded that the use of 2ml volume instead of 5ml reduced the ocular blood flow response to peribulbar anesthesia. They recommended the use of low volumes in patients with ocular vascular disease to reduce the incidence of anesthesia induced retinal ischemia especially diabetic retinopathy patients. The authors used laser interferometry and color Doppler imaging to measure ocular fundus flow amplitude and peak systolic and end diastolic flow velocities.

Pianka et al. [4], compared effect of peribulbar and subtenon anesthesia on both IOP and ocular pulse amplitude using a special tonometer. In their cohorts the IOP in both the subtenon and peribulbar groups remained stable throughout the study. While the pulsatile ocular blood flow was reduced to about 75% of the baseline values in both groups after 1min and returned to around 90% of baseline values after 10min.

In our study the pulsatility index, which is more related to the pulsatile ocular blood flow, was reduced to around 67% of the baseline values in the peribulbar groups in both control and diabetes and to around 80% of the baseline values after indicating a more favorable condition for ocular blood flow when using subtenon block:

Khan et al., in 2014 [7] investigated the effect of peribulbar and subtenon block of IOP without using hyaluronidase but he gave all patients tablet 500 mg Acetzolamide 1 hour before phacoemulsification. They found that subtenon block lead to a smaller rise in IOP just after the injection better than the peribulbar. Our study did not show any difference in the IOP measurement in the 4 groups included. The cause of the difference in our findings is that we added to the local anesthetic mixture hyaluronidase which lead to more disperse diffusion of the local anesthetic eliminating the volume effect of the local anesthetic on the IOP.

The effects of peribulbar block on the ocular blood flow is more pronounced than the subtenon block. This lead to reduction in the pulsatile element of the blood flow, putting Patients in the hazard of retinal ischemia appreciated in patients who are known to have a retinopathy.

We concluded that subtenon's block is a safe and effective alternative technique. To peribulbar block and provides more favorable conditions regarding the ocular blood flow specially in patients who have impaired retinal perfusion.

Further studies with larger sample sizes should be done to support our results, and to investigate the effect of both anesthetic techniques in patients with diagnosed retinopathy.

References


