

# ORIGINAL PAPERS

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## Intraocular Pressure Changes After Spinal Anesthesia – Acute and Subacute Effects on Surgery Patients

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### Abstract

**Background.** Spinal anesthesia has become appropriate for many surgical procedures. Neuraxial anesthesia can result in acute and late complications like hypotension, bradycardia, local anesthetic toxicity, postdural-puncture headache, backache and spinal nerve damage. Although the body's physiological responses to spinal anesthesia are well understood, its effects on intraocular pressure (IOP) haven't been mentioned before.

**Objectives.** The aim of this study was to investigate the effects of spinal anesthesia on IOP.

**Material and Methods.** Forty patients receiving spinal anesthesia for subumbilical surgery were recruited for the study, after ethics committee approval and patients' written informed consent. IOP was measured by Icare PRO tonometer (Icare, Finland) before spinal anesthesia (BS), immediately after spinal anesthesia (AS) and finally on the first postoperative day (PO1). Both eyes of the patients were included in the study.

**Results.** Thirty-eight patients completed the study. Mean BS, AS and PO1 intraocular pressures were  $16.53 \pm 3.17$  (9.40–24.00),  $17.08 \pm 3.16$  (10.00–24.00) and  $16.76 \pm 2.80$  (10.20–23.00) mm Hg, respectively. Mean IOP measurements were not statistically different among the three groups ( $p = 0.104$ ).

**Conclusions.** Spinal anesthesia alone has no acute or subacute effects on IOP. Studies can be made to evaluate the chronic effects. Further studies must be focused on the relationship between postdural puncture headache and intraocular pressure changes after spinal anesthesia (*Adv Clin Exp Med* 2015, 24, 5, 857–861).

**Key words:** spinal anesthesia, intraocular pressure, cerebrospinal pressure, glaucoma.

Many surgical procedures in general surgery, orthopedics, obstetrics and gynecology and urology can be performed under spinal anesthesia. Spinal anesthesia is a form of regional anesthesia involving injection of a local anesthetic into the subarachnoid space containing cerebrospinal fluid (CSF) with puncture of the dura mater with a special needle [1, 2]. Regional anesthesia provides early mobilization and discharge of the patient, better pain control, low cost and is suitable for many patients with pulmonary compromises. Despite the many advantages, some disadvantages also exist. Spinal or epidural

anesthesia can result in acute complications like hypotension, bradycardia, total spinal block and local anesthetic toxicity, as well as late complications like postdural puncture headache, backache, cauda equina syndrome and spinal nerve damage [2, 3].

The physiological effects of neuraxial anesthesia are well known. The acute and delayed effects of both spinal and epidural anesthesia on cardiac, pulmonary, metabolic, renal, hepatic and cerebral functions are well understood [2]. However no investigation has been made regarding the effect of spinal anesthesia on intraocular pressure (IOP).

IOP is the pressure caused by the fluid inside the eye, named aqueous humor that maintains the shape of the eye. It is determined by the balance between the rate of secretion and outflow of aqueous humor [4]. Additionally, factors like vitreous volume, choroidal blood volume, scleral rigidity and orbicularis oculi muscle tension also affect IOP [5]. The normal range of IOP is 10–20 mm Hg [6]. IOP elevation contributes to the development and progression of glaucoma [4, 7].

CSF fills spinal and intracranial spaces, as well as the optic nerve subarachnoid space (ONSAS), that surrounds the retrolaminar optic nerve behind the eye. The surface shape of the optic disc is determined by the translaminar pressure difference and gradient, that maintains the *lamina cribrosa* (LC) position [8]. The trans-LC pressure gradient depends on two factors. First is the actual pressure difference on either side of the LC and second is the distance between fluid-filled intraocular and retrobulbar compartments [9].

We have suggested that IOP may change with the spinal anesthesia procedure itself, the acute physiological responses of the body to neuraxial anesthesia and systemic and/or local side effects of the medications used during the procedure. The aim of this study was to investigate the effects of spinal anesthesia on IOP.

## Material and Methods

After institutional ethics committee approval, 40 patients undergoing peri- or sub-umbilical surgery under spinal anesthesia were enrolled for the study. Inclusion criteria were being of American Society of Anesthesiologists (ASA) I–II physiological status, age range of 18–65 years, surgery on or under umbilicus (i.e. umbilical hernia, inguinal hernia repair, pilonidal sinus excision, hemorrhoidectomy, anal fistule or fissure repair). Exclusion criteria were being of ASA III physiological status or worse, rejection of the spinal anesthesia procedure, having relative or strict contraindications for spinal anesthesia (i.e. bleeding diathesis, infection on the puncture site), having any ocular disease, having hypertension and taking any medication. Written informed consent was obtained from all the patients after explaining the procedures. Both eyes of the patients enrolled were investigated. Participants were recruited from the General Surgery Clinic at Adiyaman University Research and Educational Hospital between April 10 and 30, 2014. All patients were operated on by the same surgeon and spinal anesthesia procedures were done by the same anesthetist.

The patients were taken into the operating room 10 min before the start of the procedure.

No premedication was done. An intravenous (*iv*) line was inserted on the dorsum of the left hand or left antecubital region and 0.9% NaCl solution was started at a rate of 250 mL/h. Routine monitoring consisted of peripheral oxygen saturation (SpO<sub>2</sub>), electrocardiogram (ECG) and non-invasive blood pressure (NIBP) measurement.

Spinal anesthesia was performed in the sitting position. A puncture was made through either L<sub>3–4</sub> or L<sub>4–5</sub> intervertebral spaces using a 25-gauge Quincke spinal anesthetic needle (Spinocan®, B. Braun Melsunger, Germany) after meticulous disinfection by 10% povidone iodine. Hyperbaric bupivacaine 0.5% (Marcain Heavy 0.5%, Astra Zeneca, UK) was used as the local anesthetic for spinal anesthesia in doses of 12, 14 and 16 mg to achieve sensory block levels of T12, T10 and T8, respectively. After 30 s of injection, the patients were immediately positioned in supine. Surgery was initiated after the achievement of appropriate sensory blockade level. Patients with inappropriate sensory block level were administered general anesthesia with laryngeal mask application and these were excluded from the study. Early complications of neuraxial anesthesia, like hypotension and bradycardia, were treated with ephedrine 5 mg in increments and atropine 0.5 mg, respectively. Hypotension was regarded as systolic arterial pressure less than 90 mm Hg or  $\geq 25\%$  decline from its baseline value. Bradycardia was regarded as heart rate less than 60/min.

IOP was measured by Icare PRO tonometer (Icare, Finland) before spinal anesthesia (BS), immediately after spinal anesthesia (AS) and finally on the first postoperative day (PO1). All IOP measurements were taken in supine position and by the same examiner. Rebound tonometry (RT) measurements were performed as recommended by the manufacturer. The subjects were asked to look straight ahead to a far point while the examiner brought the tonometer near to the subject's eye. Once the tonometer was correctly adjusted, 6 IOP readings for each eye were acquired from the central cornea by lightly pressing the tonometer button. The instrument automatically averaged the six measurements, so the mean IOP was shown on the display. Only good quality measurements (as indicated by the device) were included in the statistical analysis.

Postoperatively the patients were observed in the general surgery ward. Adequate hydration and bed rest was provided for postdural puncture headache prophylaxis.

Statistical analysis was performed with SPSS 15 (Statistical Package for the Social Sciences, Chicago, Illinois) and *p* values smaller than 0.05 were considered statistically significant. Quantitative

variables are expressed as mean values  $\pm$  SD. The analysis of repeated measure ANOVA was used to compare the results of the three IOP measurement methods. *Post hoc* comparisons were made using the Bonferroni test.

## Results

Of 40 patients, 38 completed the study. Two of the patients were excluded because of the application of general anesthesia due to inadequate regional blockade. Of the patients who completed the study, 24 were male and 14 were female. Inguinal hernia repair was performed on 21, umbilical hernia repair on 2, pilonidal sinus excision on 9 and hemorrhoidectomy on 6 patients. Mean age of the patients was  $29 \pm 6.8$  (16–52) years. Demographic data of the patients is presented in Table 1.

Six patients developed hypotension just after the spinal anesthesia procedure and intervention with ephedrine was given. No other acute complications were observed regarding anesthesia and surgery. No late complications were observed in the patients, except for 2 cases with mild postdural

puncture headache on the first postoperative day. These were treated conservatively. All the patients were discharged on postoperative day one without complications.

The mean BS, AS and PO1 intraocular pressures were  $16.53 \pm 3.17$  (9.40–24.00),  $17.08 \pm 3.16$  (10.00–24.00) and  $16.76 \pm 2.80$  (10.20–23.00) mm Hg, respectively (Fig. 1). The mean IOP measurements were not statistically different among the three groups ( $p = 0.104$ ).

## Discussion

The main conclusion of the study was that spinal anesthesia application had no prominent effect on IOP. Neither immediate nor postoperative IOP values had been affected considerably.

The effects of many general anesthetic agents on intraocular pressure are well-known and many studies have been done in this respect [10]. But there were no studies regarding the relationship between IOP and spinal anesthesia. The hypothesis of the study was based on the possible relationship between CSF pressure and IOP [8, 9]. Marek et al. [11] have stated that increased trans-lamina cribrosa pressure difference (TLCPD), i.e. the difference of intraocular and orbital CSF pressures, has been investigated as a possible risk factor in the pathogenesis of glaucoma. In this construct, an increased translaminar pressure difference will occur with a relative increase in intraocular pressure or a reduction in CSF pressure [12]. Reduction of CSF pressure after spinal anesthesia is a well-known phenomenon and this plays a major role in the development of postdural puncture headache [2]. Based on this, we can state that spinal anesthesia can result in the formation of glaucoma, increasing TLCPD by decreasing CSF pressure, i.e. normal tension glaucoma. But this condition cannot be evaluated by IOP measurements alone, because the main problem here is not in the intraocular pressure elevation, but the decrease in CSF pressure.

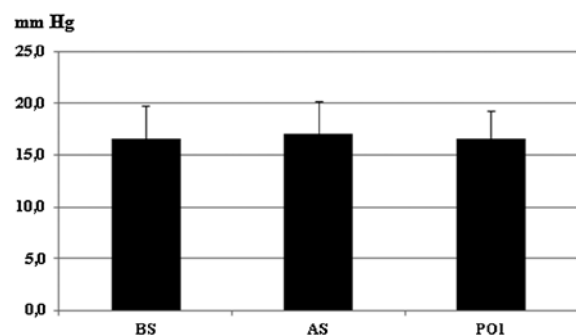
Furthermore, some studies have shown systemic blood pressure dysregulation to be associated with changes in IOP [13–15]. Patients receiving spinal anesthesia are prone to blood pressure dysregulations, so IOP changes may occur in them. Sekeryapan et al. [6] have investigated IOP changes in patients receiving spinal anesthesia and found a relationship between IOP and blood pressure, such that decreased blood pressure had a significant effect on lowering IOP. In fact, it was the only study done on the relationship between spinal anesthesia and IOP in the literature. They excluded patients receiving sympathomimetics like

**Table 1.** Demographic data of the patients

Age (years)		$29 \pm 6.8$
Sex	male	24
	female	14
Operation	inguinal hernia repair	21
	umbilical hernia repair	2
	pilonidal sinus excision	9
	hemorrhoidectomy	6
Total		38

Age is represented as mean  $\pm$  SD.

Other values indicate number of the patients.



**Fig. 1.** Time-intraocular pressure graph. Values are presented as mean  $\pm$  SD. BS – before spinal, AS – after spinal, PO1 – postoperative day 1

ephedrine to increase blood pressure after spinal anesthesia not to intervene in IOP changes related to hypotension, and found a direct relation between blood pressure and IOP. Reitsamer et al. [16] have reported that ciliary body secretory processes were blood flow dependent in rabbits. Gherezghiher et al. [17] have reported that humor aqueous production in monkeys was associated with mean arterial pressure. These findings indicate that aqueous humor production is in close relationship with mean arterial pressure, which regulates ciliary blood flow. Sekeryapan et al. [6] have stated that a decrease in mean arterial blood pressure as a result of spinal anesthesia may have an effect on IOP, probably by decreasing ciliary body blood flow. We have not reported the blood pressure values of the patients in our study, but they were kept in normal ranges. Values exceeding 25% of the baseline were immediately treated with ephedrine.

CSF pressure is dependent on cerebral perfusion pressure. Hypotension causes a decrease of cerebral perfusion pressure and so a decrease in CSF pressure [18]. Is there a relationship between intraocular and CSF pressures? The optic nerve traverses the eye through the *lamina cribrosa* and obtains an arachnoid membrane contiguous with the arachnoid of the intracranial space that contains CSF. *Lamina cribrosa* stabilizes the IOP by forming a barrier between the intraocular and extraocular spaces and prevents leakage of aqueous humor from the intraocular space into the retrobulbar CSF space. Because of this anatomical relationship, the association between CSF pressure and IOP has been investigated recently, and a correlation between CSF pressure and IOP has been postulated in different studies [19–21]. Elevated CSF pressure has shown an association with elevated IOP, and the use of IOP measurement has been suggested as an indicator of intracranial pressure [19].

CSF is located in a closed compartment in the intracranial and spinal subarachnoid spaces. Its daily production is approximately 450–500 mL, which exceeds its total volume by a factor of three in the subarachnoid space. Spinal anesthesia can also result in a drop of CSF pressure by another mechanism, simply by loss of CSF through the puncture site. If the loss of CSF from the dural hole is more than its production rate, this can

result in a decrease of CSF pressure. This is an important matter especially with the use of thicker spinal puncture needles that result in more CSF loss. A disproportionate loss of CSF through the puncture site also leads to headache, named postdural puncture headache, a common complication of spinal anesthesia, especially when thicker spinal needles are used. We suggest that studies may be conducted on patients with postdural puncture headache to exhibit the relationship between intraocular and CSF pressures.

Body position was shown to change IOP. A rise of 2–6 mm Hg was reported previously when changing from sitting to supine position [22, 23]. Spinal anesthesia may decrease this response of IOP, but more studies are needed in this respect [6].

Icare tonometry is based on the principle of rebound tonometry. This device consists of a probe with a magnetic shaft introduced into a solenoid. An electrical pulse generator creates a magnetic field and it repels the probe that moves toward the cornea, impacts and rebounds. The probe causes a voltage in the solenoid and the deceleration signal is analyzed thereafter. Deceleration increases with increased intraocular pressure [24, 25]. Measurement of IOP with RT has the advantages of not requiring topical anesthesia, minimizing corneal injury and avoiding the risk of cross infection through the use of disposable probes [26].

The main limitation of our study was that we did not prospectively record the relationship of the patients' blood pressure and AS-IOP values. After considering the suggestions regarding IOP and blood pressure association [6], we have retrospectively scanned the patients' perioperative blood pressure records, but found no association. Another limitation was that we followed the patients for only one day postoperatively. Patients might have developed postdural puncture headache later and IOP changes in them might have been observed later. So, we suggest that further studies must be carried out with longer follow-up periods.

In conclusion, spinal anesthesia alone has no acute and subacute effects on IOP. Studies can be done to evaluate the chronic effects. Further studies must be focused on the relationship between postdural puncture headache and intraocular pressure changes after spinal anesthesia.

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