Acute Effect Of Spinal Anesthesia On Intraocular Pressure

Spinal Anestezinin Göz İçi Basinci Üzerine Akut Etkisi

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ABSTARCT

Purpose: The aim of this study was to evaluate the acute effect of spinal anesthesia on intraocular pressure (IOP) in supine positioned patients underwent lower extremity surgery.

Materials and Methods: IOP was measured in all patients with Tono-Pen XL before and 20 minutes after spinal anesthesia application. Monitorization of blood pressure, peripheral oxygen saturation and electrocardiogram was initiated before spinal anesthesia and repeated at every 5 minutes during surgery and mean systemic arterial pressure measurement was recorded at the same time with IOP measurement. IOP and mean arterial pressure changes were evaluated with t test.

Results: There were ninety-eight eyes of 49 patients. The mean intraocular pressure was 18.6±2.8 mmHg before anesthesia. Twenty minutes after spinal anesthesia application, the mean IOP was reduced to 15.7±2.9 mmHg ($p<0.05$). The mean systemic arterial pressure was 109.5±16.8 mmHg before anesthesia. Twenty minutes after, the mean systemic arterial pressure was measured as 91.6±15.3 mmHg ($p<0.05$).

Conclusion: Spinal anesthesia seems to significantly decrease intraocular pressure in patients under supine positioned. Hypotension side-effect may have a role in this decrease.

Key Words: Intraocular pressure, mean arterial pressure, spinal anesthesia, supine position.

ÖZ

Amaç: Bu çalışmanın amacı, supin pozisyonda alt ekstremite cerrahisi geçiren hastalarda, spinal anestezinin göz içi basıncı (GİB) üzerine etkisinin değerlendirilmesidir.

Gereç ve Yöntem: Spinal anestezi uygulamasından önce ve 20 dk sonra tüm hastaların GİB'leri Tono-pen XL ile ölçüldü. Kan basıncı, periferik oksijen satürasyonu ve elektrokardiyografi monitörizasyonu, spinal anesteziden önce başlatıldı ve cerrahi boyunca her 5 dk'da bir tekrarlandı. GİB ölçümüyle eş zamanlı olarak ölçülen ortalama sistemik arteriyel basınç değerleri not edildi. GİB ve ortalama arteriyel basınçtaki değişiklikler t testi ile karşılaştırıldı.

Bulgular: Çalışmaya 49 hastanın 98 gözü dahil edildi. Anestezi öncesi ortalama GİB 18.6±2.8 mmHg iken spinal anestezi uygulamasından 20 dk sonra 15.7±2.9 mmHg olarak ölçüldü ($p<0.05$). Anestezi öncesi ortalama sistemik arteriyel basınç 109.5±16.8 mmHg iken, anesteziden 20 dk sonra 91.6±15.3 mmHg olarak ölçüldü ($p<0.05$).

Sonuç: Spinal anestezi supin pozisyonda göz içi basıncında anlamlı düşüşe neden olmaktadır. Spinal anestezinin hipotansiyon yan etkisinin bu düşüşte rolü olabilir.

Anahtar Kelimeler: Göz içi basıncı, ortalama arteriyel basınç, spinal anestezi, supin pozisyon.

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INTRODUCTION

The intraocular pressure (IOP) is determined by several factors like the rate of aqueous humour production, vitreous volume, choroidal blood volume, scleral rigidity, orbicularis oculi muscle tension and external pressure.[1] The normal IOP is approximately 15 mmHg, with a normal range of 10-20 mm Hg. The IOP changes that occur during non-ocular surgery have attracted the attention of researchers for many years. Studies have examined the effects of anesthetics and related drugs on IOP, although the mechanisms underlying effects on IOP remain largely unclear.[2-4] The relation between body position and IOP has been also investigated and several authors have reported an increase on IOP when body position is changed from sitting to supine which is the most common surgical position.[5-7]

Spinal anesthesia which is a type of regional anesthesia is commonly used for lower abdomen, inguinal and lower extremity surgeries. In spinal anesthesia, local anesthetics are injected into subarachnoid space which contains cerebrospinal fluid (CSF) with puncture of dura mater. This study was aimed to investigate the effect of spinal anesthesia on IOP during supine positioned lower extremity surgery.

MATERIALS AND METHODS

This prospective study included patients who underwent elective lower extremity surgery under spinal anesthesia. Written informed consent was obtained from all participants after the nature of the study was fully explained and the study received approval from University Medical School Ethics Committee.

Inclusion criteria were age greater than 18 years, ASA I or II physical status. Exclusion criteria was medical history of glaucoma, diabetes mellitus, severe hypertension, decompensated heart failure, physical status worse than ASA II and contraindications to central neural blockade.

Before anesthesia, lactated Ringer solution 7 mL/kg was infused through a 20 Gauge IV cannula at the forearm. No premedication was applied. Monitorization of blood pressure, peripheral oxygen saturation and electrocardiogram (with Dräger Infinity® Kappa patient monitor) was initiated 20 minutes before regional nerve block and repeated at every 5 minutes during surgery.

Spinal anesthesia was performed in the sitting position under sterile conditions. After infiltration of the puncture site with 2 mL lidocaine 1%, subarachnoid space was entered at the L_{3-4} interspace via midline approach using a 25-gauge spinal needle. Dural tap was performed and after free flow of clear CSF, 10 mg hyperbaric bupivacaine 0.5% was injected within 30-35 seconds. To determine the dermatomal level of sensory block, pinprick test was used. The onset time and level of sensory block was noted for every patient. The patients which required ephedrine treatment for hypotension during surgery were excluded not to effect the intraocular pressure measurement.

IOP was measured with Tono-Pen® XL (Reichert Inc, Depew, New York, USA) before spinal anesthesia in sitting position and 20 minutes after spinal anesthesia in supine position. The ophthalmologist who measured IOP, remained blinded about the values of two consecutive measurements. With the eye under good illumination, under topical anesthesia, the Tono-Pen was oriented perpendicular to the cornea and the tip was brought into contact with the cornea. All valid readings occurred immediately after contact of the Tono-Pen tip with the eye, holding the contact long enough to see the pressure readout. The measurement was repeated three times for each eye and the mean value of three measurements was recorded. Additionally, mean systemic arterial pressure which was measured in supine position at the same time with IOP measurement was noted. Statistical analysis of intraocular pressure and mean systemic arterial pressure measurements were carried out using t test. $p<0.05$ was considered statistically significant.

RESULTS

After exclusion of the patients which had ephedrine treatment during spinal anesthesia, a total of 98 eyes of 49 patients were evaluated. The mean age was 51.8±15 years (25-82). The mean onset time of sensory block was <5 minutes. The mean sensory block level was T8 (range T6-T12). The mean IOP of 98 eyes was 18.6±2.8 mmHg (11-26) before anesthesia. Twenty minutes after anesthesia application, the mean IOP reduced to 15.7±2.9 mmHg (10-21) ($p<0.05$, paired t test). When IOP was evaluated due to laterality, before anesthesia, the mean IOP of right and left eyes were 18.7±3.1 mmHg and 18.6±3.1 mmHg, respectively.

Table: *IOP measurements (mean±SD) before and after spinal anesthesia.*

	IOP (total eyes)	IOP (right eyes)	IOP (left eyes)
Before spinal anesthesia	18.6±2.8 mmHg	18.7±3.1 mmHg	18.6±3.1 mmHg
20 minutes after spinal anesthesia	15.7±2.9 mmHg	15.4±3.0 mmHg	15.6±2.5 mmHg

After 20 minutes, the mean IOP was measured as 15.4±3.0 mmHg in the right eye and 15.6±2.5 mmHg on the left (Table). There was no difference between right and left eyes with respect to IOP measurement before and 20 minutes after spinal anesthesia ($p>0.05$, independent t test). The mean systemic arterial pressure was 109.5±16.8 mmHg (83-152) before anesthesia. Twenty minutes after anesthesia, at the same time with IOP measurement, the mean systemic arterial pressure was measured as 91.6±15.3 mmHg (65-127), ($p<0.05$, paired t test).

DISCUSSION

The idea of this study was hypothesised on two possible ways. First way was the effect of spinal anesthesia on systemic blood pressure. Hypotension is an expected cardiovascular event following spinal anesthesia.[8] The expected drop in blood pressure following spinal anesthesia is usually about 20% and is predominantly due to arterial and arteriolar vasodilation secondary to sympathetic blockade. The relation between mean arterial pressure changes and IOP has attracted the attention of researchers for many years. According to a study, the aqueous production in monkeys is affected by decrease in mean arterial pressure when it falls below 70 to 90 mm Hg.[9]

Supporting this idea, it was reported that ciliary body secretory processes were blood flow dependent when blood flow was reduced below 74% of baseline.[10] These findings indicate the existence of an association between aqueous humor formation and mean arterial pressure which can regulate ciliary blood flow. Lack of autoregulation mechanism in the ciliary body also supports this idea. Based on these findings, in this study, the significant decrease on mean systemic arterial pressure secondary to spinal anesthesia seems to have an effect on IOP drop, probably by decreasing ciliary body blood flow.

Similarly, CSF production is dependent on the cerebral perfusion pressure. Hypotension causes a decrease on cerebral perfusion pressure, and with the reduction in cerebral and choroid plexus blood flow, CSF production and so intracranial pressure may decrease.[11, 12] So is there any relationship between intracranial and intraocular pressures? The second theory resulted from this question.

Optic nerve traverses the eye through the lamina cribrosa and acquires an arachnoid membrane that is contiguous with the arachnoid of the intracranial space. This arrangement permits a free circulation of CSF around the retrobulbar optic nerve. IOP is mainly determined by rate of aqueous humor secretion from ciliary body and outflow from trabecular meshwork. However, choroidal blood volume, central venous pressure, extraocular muscle tone, vitreous volume, and external pressure may play role on IOP determination. Lamina cribrosa stabilize the IOP by forming a barrier between the intraocular and extraocular spaces and prevents a major leakage of aqueous humor from the intraocular space into the retrobulbar cerebrospinal fluid space. Because of the anatomical adjacency of these two liquid containing system, association between CSF pressure and IOP has been investigated recently, and, a correlation between CSF pressure and IOP has been postulated in different studies.[13-15] Elevated CSF pressure has showed association with elevated IOP, and the use of IOP measurement has been suggested as an indicator of intracranial pressure.[13]

During spinal anesthesia procedure, the subarachnoid space, which can be thought as an enclosed and liquid containing system, loses its integrity. In this study, the cerebrospinal fluid pressure changes during spinal anesthesia procedure were not evaluated. Actually, it is hard to generalize the spinal anesthesia's effects on cerebrospinal fluid pressure because the CSF leakage mainly depends on the technique and needle type. Headache, the most common complication of dural puncture,[16] is due to leakage of CSF through the dural puncture site faster than its production rate.[17] But, with the use of small gauge needles, the leakage of cerebrospinal fluid has been mostly prevented and the incidence of post-spinal headaches was significantly reduced.[18] In this study, 25 gauge needle was used for spinal anesthesia, so CSF volume change due to technique was theoretically thought to be insignificant. However, as mentioned above, secondary to hypotension, CSF production and so intracranial pressure may decrease acutely. But, since the CSF pressure was not measured during the spinal anesthesia, further research is needed to explore the second theory.

The effects of other types of anesthesia on IOP were investigated previously. It was shown that tracheal intubation increased IOP and mean arterial pressure.[19] However laryngeal mask airway has been found to be superior to tracheal intubation in terms of maintaining stable IOP and haemodynamics.[20] Also, there is a large and individually variable rise in IOP following peribulbar anesthesia.[21] The effects of topical anesthesia on IOP are controversial, it was reported to cause a significant reduction in IOP.[22] Due to our results, spinal anesthesia seems to be superior to tracheal intubation and periocular anesthesia in terms of reducing IOP.

It was shown that a change in body position alters intraocular pressure. Many lower extremity procedures require supine position.

An average rise of 2-3 mmHg in intraocular pressure when body position is changed from sitting to supine was reported.[5] Some even reported changes as high as 6 mmHg.[6] Additionally, the increase on IOP due to position changing from sitting to supine, remained stable in supine position after 30 minutes.[7] So according to our study, spinal anesthesia eliminates IOP increase secondary to supine position.

In the current study, Tono-Pen XL was used to measure IOP. The Tono-Pen XL is a hand-held tonometer which has acceptable results compared with Goldmann applanation tonometer.[23,24] The Goldmann applanation is currently the gold standard for IOP measurement and is in widespread use in clinical practice.[25] However, Tono-Pen XL is more usable in clinical and experimental studies because of its compact, portable, easily calibrated properties.

CONCLUSION

In conclusion, spinal anesthesia seems to reduce IOP acutely presumably by decreasing mean systemic arterial pressure. This finding may be important for decision of supine positioned lower extremity surgeries in patients who have preexisting glaucomatous damages. However, further studies focusing on IOP changes in patients with glaucoma are required.

REFERENCES/KAYNAKLAR

1. Cunningham AJ, Barry P. Intraocular pressure physiology and implications for anaesthetic management. Can Anaesth Soc J 1986;33:195-208.
2. Thomson MF, Brock Utne JG, Bean P, et al. Anaesthesia and intraocular pressure: a comparison of total intravenous anaesthesia using etomidate with conventional inhalation anaesthesia. Anaesthesia 1982;37:758-61.
3. Artru AA, Momota Y. Trabecular outflow facility and formation rate of aqueous humor during anesthesia with sevoflurane nitrous oxide or sevoflurane-remifentanil in rabbits. Anesth Analg 1999;88:781-6.
4. Nagdeve NG, Yaddanapudi S, Pandav SS. The effect of different doses of ketamine on intraocular pressure in anesthetized children. J Pediatr Ophthalmol Strabismus 2006;43:219-23.
5. Galin MA, McIvor JW, Brock Magruden G. Influence of position on intraocular pressure. AmJ Ophthalmol 1963;55:720-3.
6. Weber AK, Price J. Pressure differential of intraocular pressure measured between supine and sitting position. Ann Ophthalmol 1981;13:323-6.
7. Yamabayashi S, Aguilar RN, Hosoda M, et al. Postural change of intraocular and blood pressures in ocular hypertension and low tension glaucoma. Br J Ophthalmol 1991;75:652-5.
8. Faccenda KA, Finucane BT. Complications of regional anaesthesia Incidence and prevention. Drug Saf 2001;24:413-42.
9. Gherezghiher T, Hey JA, Koss MC. Systemic blood pressure and intraocular pressure relationship. J Ocul Pharmacol 1988;4:291-301.
10. Reitsamer HA, Kiel JW. Relationship between ciliary blood flow and aqueous production in rabbits. Invest Ophthalmol Vis Sci 2003;44:3967-1.
11. Rosner MJ, Daughton S. Cerebral perfusion pressure management in head injury. J Trauma 1990;30:933-41.
12. Rosner MJ, Rosner SD, Johnson AH. Cerebral perfusion pressure: management protocol and clinical results. J Neurosurg 1995;83:949-62.
13. Salman MS. Can intracranial pressure be measured non-invasively? Lancet 1997;350:1367.
14. Sheeran P, Bland JM, Hall GM. Intraocular pressure changes and alterations in intracranial pressure. Lancet 2000;355:899.
15. Lashutka MK, Chandra A, Murray HN, et al. The relationship of intraocular pressure to intracranial pressure. Ann Emerg Med 2004;43:585-91.
16. Olsen KS. Epidural blood patch in the treatment of post-lumbar puncture headache. Pain 1987;30:293-301.
17. Tourtellote WW, Henderson WG, Tucker RP, Gilland et al. A randomized double-blind clinical trial comparing 22 versus the 26 gauge needle in the production of the post-lumbar puncture syndrome in normal individuals. Headache 1972;12:73-8.
18. Lynch J, Krings-Ernst I, Strick K, et al. Use of a 25 gauge Whitacre needle to reduce the incidence of post-dural puncture headache. Br J Anaesth 1991;67:692-3.
19. Wynands JF, Cromwell DF. Intraoccular tension in association with succinylcholine and endotracheal intubation: a preliminary report. Can Anaesth Soc J. 1960;7:39-43.
20. Lamb K, James MF, Janicki PK. The laryngeal mask airway for intraocular surgery: effects on intraocular pressure and stress responses. Br J Anaesth. 1992;69:143-7.
21. Bowman R, Liu C, Sarkies N. Intraocular pressure changes after peribulbar injections with and without ocular compression. Br J Ophthalmol 1996;80:394-7.
22. Almubrad TM, Ogbuehi KC. Clinical investigation of the effect of topical anesthesia on intraocular pressure. Clin Ophthalmol 2007;1:305-9.
23. Kao SF, Lichter PR, Bergstrom TJ, et al. Clinical comparison of the Oculab Tono-Pen to the Goldmann applanation tonometer. Ophthalmology 1987;94:1541-4.
24. Chou CY, Jordan CA, McGhee CN, et al. Comparison of Intraocular Pressure Measurement Using 4 Different Instruments Following Penetrating Keratoplasty. Am J Ophthalmol 2011:13.
25. International Organization for Standardization. Ophthalmic Instruments-Tonometers: ISO8612:2001. Geneva, Switzerland: International Organization for Standardization; 2001.