

Patient Positioning and Factors that Affect IOP During Ophthalmic Surgery

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Disclosures

- None



Learning Objectives

- Understand patient positioning concerns during ophthalmic anesthesia
- Understand the significance of ocular perfusion pressure (OPP)
- Understand perioperative factors that affect IOP

Avoiding Complications From Patient Positioning for Intraocular Surgery

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Collaboration of the surgical and anesthesia teams for patient positioning is essential to assure patient comfort and safety, preventing systemic and ophthalmic complications. The goals and rationales of positioning for intraocular surgery are discussed including placing the head above the heart, elevating the chin, using a head rest that is sufficiently firm, maximizing anesthesia care team access and minimizing fire risk, and taping the patient's head to the operating table to reduce unexpected movement with intraocular injury. (Anesth Analg 2018;126:1206–11)

Chronopoulos A, Herbert J, Thumann G, Schutz JS. Avoiding Complications From Patient Positioning for Intraocular Surgery. Anesth Analg. 2018 Apr;126(4):1206-1211

Positioning Head Above Heart

- Tilt Top half of table about 20 degrees at the waist of patient
- Elevate chin to sniffing position for airway and horizontal plane of eye
- Minimizes “bulgy eye”

Table 3. Effects of Positioning the Head Above the Heart

Potential benefits

- Reduces venous pressure in the head (choroid and orbit)
- Decreases bleeding
- Decreases positive vitreous pressure
- Helps prevent decompensation of congestive heart failure
- Relieves pressure on diaphragm facilitating breathing in obese patients

Potential detriments

- Increased risk of aspiration
- Venous stasis in the lower extremities and its complications
- Decreased cerebral perfusion/stroke

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Patient Positioning

— Arms

- Draw sheet is placed over the arm then under the arm rather than tucked under the mattress
- Avoid compression of arm by the overhead table
- Inform patient why arm restraint is necessary

— Legs

- Uncrossed to prevent venous compression
- Pillow under knees to prevent low back pain
- Safety belt above knees to prevent patient movement

Patient Positioning

— Drapes and Anesthesia Team Access

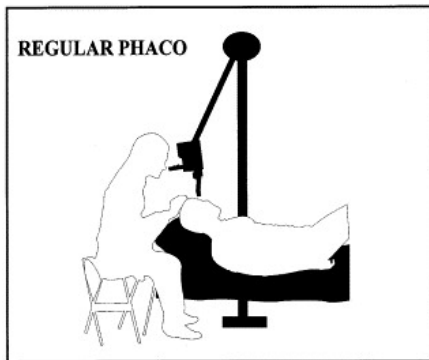
- Keep drapes elevated above patient face except for eye
 - Patient comfort- avoid smothering sensation
 - Escape for excess supplemental oxygen and expired CO₂- reduces fire risk and hypercapnia (suction tubing may be used, special drapes)
 - Use of overhead table, tenting drapes, etc. can assist with this
- Maintain nonverbal communication when patient instructed not to speak or move
 - Hold patient's hand and instruct that a squeeze from patient indicates there is a problem

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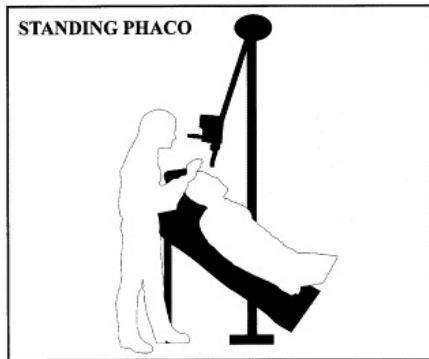
Overhead Table



Reverse Trendelenburg, Standing Phacoemulsification Case



Top: The standard sitting-surgeon position with the patient in the supine position.



Bottom: The SPT with the patient in RTP

Mansour AM, Al-Dairy M. Modifications in cataract surgery for the morbidly obese patient. *J Cataract Refract Surg.* 2004;30:2265–2268

Positioning Challenges

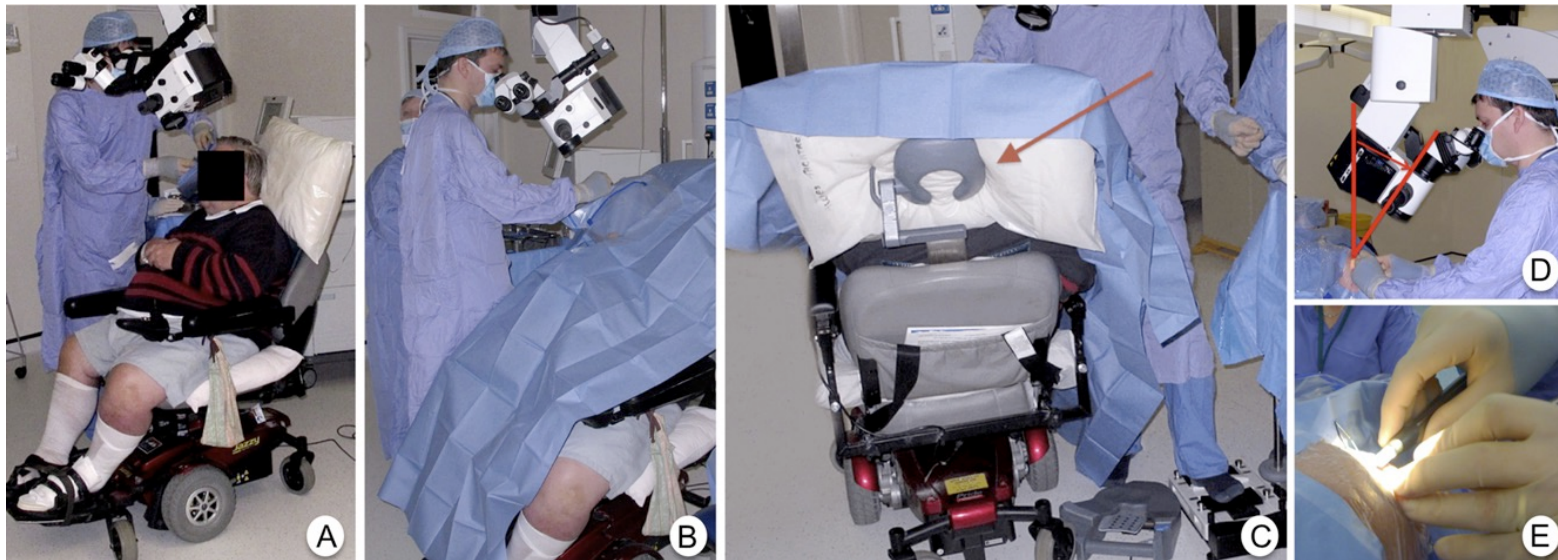


“Face-to-Face” approach

Sometimes referred to as **“side saddle”** cataract surgery

Ang GS, Ong JM, Eke T. Face-to-face seated positioning for phacoemulsification in patients unable to lie flat for cataract surgery. *Am J Ophthalmol.* 2006;141:1151–1152

Motorized Wheelchair Case



Pajaujis M, Injarie A, Eke T. Extreme face-to-face positioning for cataract surgery with patient seated upright in motorized wheelchair. J Cataract Refract Surg. 2013;39:804–805

Pillow Case



Gordon MI, Rodríguez AA, Olson MD, Miller KM. Pillow case. J Cataract Refract Surg. 2005;31:1824–1825

Kelly DJ, Farrell SM. Physiology and role of intraocular pressure in contemporary anesthesia. *Anesth Analg* 2018;126:1551–62

Physiology and Role of Intraocular Pressure in Contemporary Anesthesia

Dermot J. Kelly, MRCPI, FFARCSI, DABA, and Sinéad M. Farrell, MRCPI, MCAI

More than 26 million Americans suffer with cataracts, and with 3.6 million cataract extractions performed annually in the United States, it is the most common surgical procedure. The integrity of the delicate structures of the eye that mediate vision is dependent on the intraocular pressure (IOP). Yet, IOP acts to compress the vessels within the globe—akin to a Starling resistor—and is a key component that determines the ocular perfusion pressure, defined as the difference between arterial pressure and IOP. The retina is one of the most metabolically active tissues in the body, and its functional integrity is dependent on an adequate blood supply, with retinal function linearly related to the ocular perfusion pressure. Retinal cell death has been demonstrated at low perfusion pressures (below 50 mm Hg). Modern ophthalmic surgery involves globe irrigation, manipulation, and instrumentation, resulting in dynamic pressure fluxes within the eye. Marked elevations of IOP (up to 4–5 times the normal value) with consequent borderline retinal and optic disk perfusion pressures occur for prolonged periods during many ophthalmic procedures. General surgeries, including laparoscopic, spinal, and cardiac procedures, especially, with their demand for steep Trendelenburg or prolonged prone positioning and/or hypotensive anesthesia, can induce IOP changes and ocular perfusion imbalance. These rapid fluctuations in IOP and so in perfusion, play a role in the pathogenesis of the visual field defects and associated ocular morbidity that frequently complicate otherwise uneventful surgeries. The exact etiology of such outcomes is multifactorial, but ocular hypoperfusion plays a significant and frequently avoidable role. Those with preexisting compromised ocular blood flow are especially vulnerable to intraoperative ischemia, including those with hypertension, diabetes, atherosclerosis, or glaucoma. However, overly aggressive management of arterial pressure and IOP may not be possible given a patient's comorbidity status, and it potentially exposes the patient to risk of catastrophic choroidal hemorrhage. Anesthetic management significantly influences the pressure changes in the eye throughout the perioperative period. Strategies to safeguard retinal perfusion, reduce the ischemic risk, and minimize the potential for expulsive bleeding must be central to the anesthetic techniques selected. This review outlines: important physiological principles; ophthalmic and general procedures most likely to develop damaging IOP levels and their causative factors; the effect of anesthetic agents and techniques on IOP; recent scientific evidence highlighting the significance of perfusion changes during surgery; and key aspects of postoperative visual loss and management approaches for high-risk patients presenting for surgery. (*Anesth Analg* 2018;126:1551–62)

- **OPP= Arterial pressure - IOP**
- Retinal cell death at low perfusion pressures (< 50mmHg)
- Risk of choroidal hemorrhage with overly aggressive management of arterial pressure and IOP
- Anesthetic management significantly influences pressure changes in the eye

Factors Affecting IOP

1. **Neural Influences:** neurogenic regulation of extraocular muscle tone
2. **Aqueous Humor:** balance between aqueous humor production and outflow rates is the chief physiologic regulator of IOP
3. **Choroidal Blood Volume and Flow:** impaired venous outflow will cause engorgement and rise in IOP which is partially compensated for by increased aqueous humor outflow (over 15-30 minutes)
4. **Vitreous Humor**

Medications to Decrease IOP

— Acetazolamide

- Carbonic anhydrase inhibitor
- Decreases secretion of aqueous humor
- Induces alkaline diuresis and can result in K⁺ depletion
- Dose **125-250 mg IV/PO** q 4hr (doses > 1g/day are rarely more effective)
- Ophthalmologist may request **500 mg IV**

— Mannitol

- Osmotic diuretic
- Increases circulating blood volume
 - May precipitate CHF if given too quickly in patients with poor ventricular function
 - May need urinary catheter during surgery to avoid over-distension of bladder
- Dose **1.5-2 g/kg IV** x1 (give 30-90 minutes before surgery)
 - Ophthalmologist may request lower dose of **12.5g IV** which has been shown to reduce IOP from 30-120 minutes

Mauger TF, Nye CN, Boyle KA. Intraocular pressure, anterior chamber depth and axial length following intravenous mannitol. J Ocul Pharmacol Ther. 2000;16(6):591–594

Classification of Ophthalmic Surgery

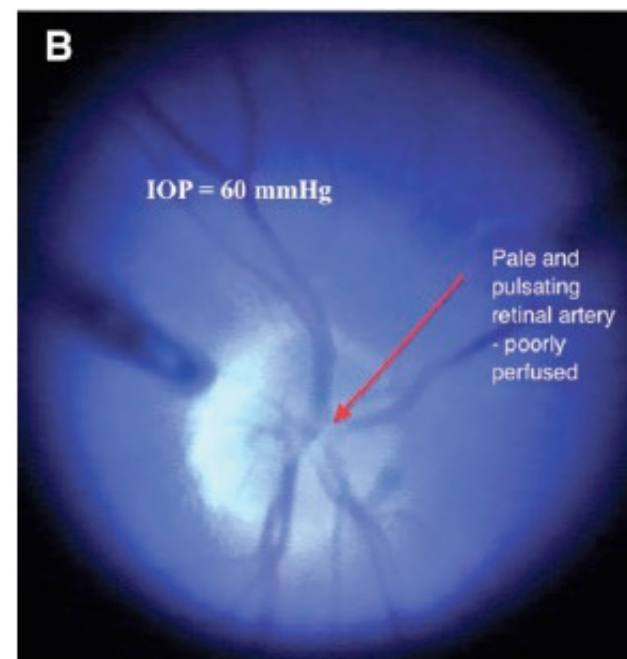
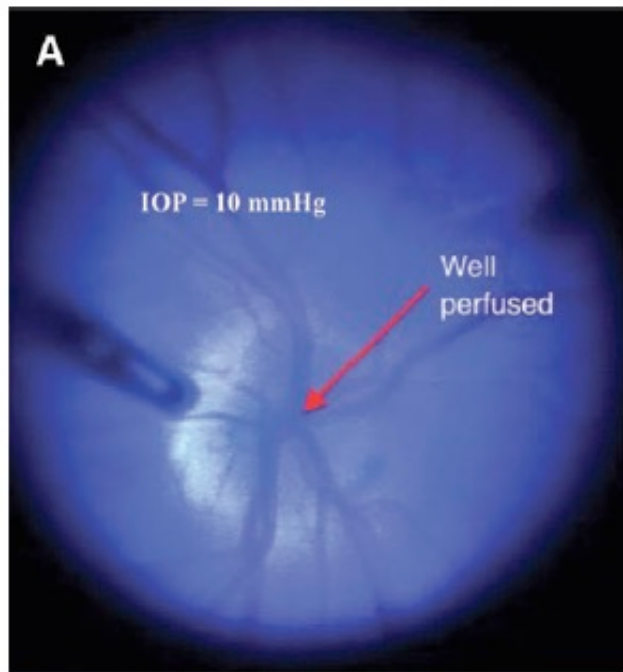
1. Open Eye Procedures

- IOP concept does not exist
- “Positive vitreous pressure”
 - Caused by pressure on scleral wall (extraocular muscle tension) or intra-ocular mass (choroidal effusion or hematoma)
 - Reduction in volume of scleral cavity manifested by
 - Extrusion of ocular contents, iris prolapse, and vitreous loss
 - Choroidal effusion or hemorrhage

2. Closed Eye Procedures

- IOP pressure varies as no communication exists to atmosphere to mitigate pressure rise
- MAP elevation unable to fully compensate for retinal dysfunction caused by same degree of IOP elevation

Optic Disc Circulation with IOP Change



van Heuven WA, Kiel JW. ROP surgery and ocular circulation. Eye (Lond). 2008;22:1267-1272

Choroidal Hemorrhage Risk

- Increase in OPP (increased MAP or decreased IOP) may precipitate choroidal hemorrhage
- Due to **increased transmural pressure** across choroidal plexus vessels
 - Surgical incision and resulting ocular decompression decreases IOP
 - Arterial and venous pressure elevations produced by Valsalva maneuver, coughing, sneezing, bucking on ETT
- **GOAL:** minimize retinal ischemic damage risk while limiting the transmural pressure gradient

IOP Increased

Table 1. Physiological Factors Increasing IOP^{55,60,106,107,111,112}

Action	Magnitude of IOP Increase (mm Hg)
Supine position	3–5
Prone position	8–20
Blinking	10
Trendelenburg position (25°)	13
Cough	40
Eyelid squeeze	50–90

Kelly DJ, Farrell SM. Physiology and role of intraocular pressure in contemporary anesthesia. *Anesth Analg* 2018;126:1551–62

Anesthetic Induction, Maintenance Agents, and IOP

- **Anesthesia Mask:** may drastically increase IOP if poorly placed
- **Direct laryngoscopy:** Macintosh blade (7-13mmHg)>video laryngoscope>LMA
- **Propofol:** reduces IOP up to 40% with induction doses and 17-27% reduction at doses ≤ 1 mg/kg due to depression of ocular centers in the brain resulting in extraocular muscle relaxation
- **Etomidate:** reduces IOP up to 30%
- **Ketamine:** current evidence refutes belief that it increases IOP
- **Volatile agents:** reduce IOP, sevoflurane=propofol but sevoflurane<propofol when both combined with remifentanyl
- **Nitrous Oxide:** no effect on IOP

-Famewo CE, Odugbesan CO, Osuntokun OO. Effect of etomidate on intra-ocular pressure. Can Anaesth Soc J. 1977;24:712–716

-Neel S, Deitch R Jr, Moorthy SS, Dierdorf S, Yee R. Changes in intraocular pressure during low dose intravenous sedation with propofol before cataract surgery. Br J Ophthalmol. 1995;79:1093–1097

-Drayna PC, Estrada C, Wang W, Saville BR, Arnold DH. Ketamine is not associated with elevation of intraocular pressure during procedural sedation. Am J Emerg Med. 2012;30:1215–1218

Opioids, Dexmedetomidine, and Midazolam

- **Fentanyl, alfentanil, sufentanil:** significantly reduce IOP during induction and after laryngoscopy and succinylcholine administration
- **Dexmedetomidine:** attenuates IOP increase during laryngoscopy
- **Midazolam:** little to no effect on IOP

-Sweeney J, Underhill S, Dowd T, Mostafa SM. Modification by fentanyl and alfentanil of the intraocular pressure response to suxamethonium and tracheal intubation. Br J Anaesth. 1989;63:688–691

-Domi RQ. A comparison of the effects of sufentanil and fentanyl on intraocular pressure changes due to easy and difficult tracheal intubations. Saudi Med J. 2010;31:29–31

-Kaya FN, Yavascaoglu B, Baykara M, Altun GT, Gülhan N, Ata F. Effect of oral gabapentin on the intraocular pressure and haemodynamic responses induced by tracheal intubation. Acta Anaesthesiol Scand. 2008;52:1076–1080

Neuromuscular Blockers and Reversal Agents

- **Succinylcholine:** increases IOP by 6-12 mmHg
 - pretreatment with non-depolarizing agent is inconsistent in preventing IOP increase
- **Rocuronium:** reduces IOP
- **Neostigmine/glycopyrrolate:** increases IOP 7.5 mmHg
- **Sugammadex:** no change in IOP
- **Overall effect of GA: reduction in IOP** despite laryngoscopy and intubation
- **EMERGENCE:** coughing and bucking on ETT associated with IOP increase of 40mmHg

–Cook JH. The effect of suxamethonium on intraocular pressure. Anaesthesia. 1981;36:359–365

–Bowen DJ, McGrand JC, Palmer RJ. Intraocular pressures after suxamethonium and endotracheal intubation in patients pretreated with pancuronium. Br J Anaesth. 1976;48:1201–1205

–Yagan O, Karakahya RH, Tas N, Canakci E, Hanci V, Yurtlu BS. Intraocular pressure changes associated with tracheal extubation: comparison of sugammadex with conventional reversal of neuromuscular blockade. J Pak Med Assoc. 2015;65:1219–1225

Regional Anesthesia

- Orbital cavity has capacity of 30 mL
- 5-10 mmHg increase in IOP initially with blocks but falls to below baseline values within 5 minutes
- IOP increase: peribulbar > retrobulbar and sub-Tenon's approach

-Alwitry A, Koshy Z, Browning AC, Kiel W, Holden R. The effect of sub-Tenon's anaesthesia on intraocular pressure. Eye (Lond). 2001;15:733–735.

-Bowman R, Liu C, Sarkies N. Intraocular pressure changes after peribulbar injections with and without ocular compression. Br J Ophthalmol. 1996;80:394–397.

-Patton N, Malik TY, Aslam TM, Vallance JH. Effect of volume used in sub-Tenon's anaesthesia on efficacy and intraocular pressure: a randomized clinical trial of 3 mL versus 5 mL. Clin Exp Ophthalmol. 2004;32:488–491

Summary

- ❖ Positioning of head above the heart to reduce ocular congestion is helpful, particularly during open intraocular surgery
- ❖ Many imaginative solutions exist for patients that are difficult to position
- ❖ BP management should aim to maintain retinal perfusion while also limiting risk of choroidal hemorrhage
- ❖ Most anesthetic agents either reduce or have little effect on IOP
- ❖ Overall effect of GA induction is reduction in IOP despite laryngoscopy and intubation
- ❖ Pressure on the globe, coughing, bucking on the ETT, and eyelid squeeze significantly affect IOP and “positive vitreous pressure”