

Effect of general anesthesia on intraocular pressure in Chinese children.

Junpeng Wang^{1#}, Hong Wei^{2#}, Tieli Dong^{1*}

¹Department of Anesthesiology, the Second Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan, PR China

²Department of Cardiac Surgery, the Second Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan, PR China

[#]These authors contributed equally to this work

Abstract

Objective: We aimed to assess the Intraocular Pressure (IP) normal distribution amid General Anesthesia (GA) in healthy children and to evaluate contrasts in IP with respect to anesthetics utilized and estimation timepoint.

Methods: Between May 2015 and October 2015, 120 children without glaucoma history planned for non-intraocular surgeries under GA induction by sevoflurane (A) or propofol (B) while maintenance using sevoflurane+remifentanyl (C) or propofol+remifentanyl (D). Children were categorized into 4 groups (AC, AD, BD and BC). Haemodynamic characteristics as well as IP are studied in two eyes in 4 defined time points utilizing Perkins Applanation Tonometer: a) prior to GA induction (GA1) b) just post GA induction but prior to laryngeal mask (GA2) c) amid mechanical-ventilation (GA3) and 4) post extubating (GA4). Multiple variate repeat measure Analysis of Variance (ANOVA) was utilized to compare IP contrasts in 2 eyes at defined time points and GA amid examination period while Pearson's correlation coefficient for additional investigation of relation among heart rates, systolic blood pressures, and IPs'.

Results: GA demonstrated significant reduction in IP. Mean IP overall estimate was 6.9 ± 3.3 mmHg and was under normal distribution. IP was noted to be 7.51 ± 2.74 mmHg amid GA1 with significant decrease ($p < 0.001$) to 5.67 ± 2.98 mmHg amid GA2 and significant increase ($p = 0.011$) to 6.96 ± 2.24 mmHg amid GA3 and further increase ($p = 0.042$) to 7.95 ± 4.68 mmHg at GA4. Amid GA2, significant decrease ($p < 0.05$) in IP in all subcategories in comparison to GA1 was observed. Amid GA3 and GA4, IP raised again in all categories. Amid GA4, IP was significantly low in AC category than BD ($p < 0.01$) and AD categories ($p = 0.031$). No significant contrasts in IP with respect to operation type, sex, and age was noted.

Conclusion: All in all, the study demonstrates significant reduction in IP by GA in pediatrics. No significant contrasts among subcategories at time points GA1 to GA3 was observed, however IP is fluctuating amid GA based on time points of estimation. Low IP could be measured instantly post GA induction. This ought to be contemplated while estimating IP under GA.

Keywords: Anesthesia, Glaucoma, Intraocular pressure.

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Introduction

The major risk-factor for gradual optic fiber impairment/damage in glaucoma is raise in Intraocular Pressure (IP). In pediatric patients having glaucoma, measuring of IP reliably and accurately is very critical to diagnose and follow-up. As children, doesn't comply much, IP measurements are mostly just practicable under General Anesthesia (GA) or deeper sedation utilization. Although, GA itself might impact IP, based on kind utilized and sedation depth. Flow of aqueous humor, chemical control and auto regulation of choroidal blood volume, blood pressure in venae cavae, as well as extraocular muscles tone are vital variables that influence IP. A few information is accessible in literature regarding old anesthesia

regimes. Anesthetic medications, involving intravenous/volatile agents, as well as muscular relaxing agents, could modify IP [1-3]. The courses in way they influence IP might vary. As an instance, Ketamine was noted to demonstrate raised/no impact on IP in many reviews. Ketamine exhibits dose-dependent effect on IP in children anesthetized using halothane. The higher doses of ketamine are associated with raised incidence of post-operative complications. More established inhalation anesthetics like halothane was noted to show significant reduction in IP. Succinylcholine, frequently utilized amid fast tracheal intubations, was noted to raise IP significantly [4-11].

Hitherto, there is a dearth of information regarding IP modifications brought on by GA/sedation in Chinese children. More research needs to be done in this area as proper ophthalmology therapy might alter when there is raise/reduction in IP because of anesthetic agent in correlation with the typical phase. Measuring of IP reliably is essential for right assessment of IP in kids and therapy plans of infants having glaucoma. Hence, we aimed to assess the IP normal distribution amid GA in healthy children and to evaluate contrasts in IP with respect to anesthetics utilized and estimation timepoint.

Methods

This prospective-observational study received approval from the ethics committee of The Second Affiliated Hospital of Zhengzhou University and informed consent was acquired from parents of included children. Patient confidentiality was strictly maintained. The review was directed as per the Helsinki Declaration. Pediatrics coming under American Society of Anesthesiologists (ASA) classifications 1 as well as 2 and planned for elective non-intraocular surgeries under GA was qualified to be included in study. Exclusion criteria included patients having glaucoma, those who underwent intraocular operation, and those taking IP influencing drugs. Moreover, new-born children with conceivably troublesome airways, anomalies of receptive airways, indications of upper-respiratory contamination, or requirement for quick sequence intubation were not included.

Prior to the method, patients were on fasting (6 h for solid foods while 2 h for liquids). As a pre-medication, midazolam was administered orally (0.4 mg/kg). Routine monitoring, involving non-invasive blood pressure evaluation, electrocardiography, and pulse oximeter were utilized. Temperature of body was likewise checked. Induction of anesthesia is done by sevoflurane inhalation (expired 6vol % conc. primarily till insertion of intra-venous line, and after that down titration to expired 2.5 vol% conc.) or utilizing intra-venous propofol 3-5 mg/kg. Maintenance of GA is done using balance anesthesia utilizing sevoflurane (end tidal 2.5 vol% conc.) or propofol infusion 6-8 mg/kg/h continuously. Remifentanyl 0.2 µg/kg/min was utilized in above two scenarios. Patients were on laryngeal masks. The Fresh-Gas-Flow (FGF) is kept 6 L/min. Firstly, breath was spontaneous and thereafter gentle manual assistance was given for ventilation with 35 to 45 mmHg end tidal CO₂ target. Inhalation and exhalation sevoflurane concentration as well as end tidal CO₂ are on continuous monitoring. Induction of GA is done by sevoflurane (A) or propofol (B) while maintenance was done using sevoflurane+remifentanyl (C) or propofol+remifentanyl (D).

Haemodynamic characteristics as well as IP are studied in two eyes at 4 defined timepoints as mentioned below utilizing Perkins Applanation Tonometer (HaagStreit Diagnostics) [12,13]: a) prior to GA induction (GA1) b) just post GA induction but prior to laryngeal mask (GA2) c) amid mechanical-ventilation (GA3) and 4) post extubating (GA4).

The examinations are done in horizontal binocular manner post fluorescent eye drop application (Thilorbin-oxybuprocaine Hcl 4 mg/ml and fluorescein sodium 0.8 mg/ml). Haemodynamic characteristics and IP are noted parallel including exhalation sevoflurane concentration as well as expiratory CO₂. Alterations in IP with respect to kind and phase of anesthesia include the primary endpoint.

Values are expressed as numbers and percentage and mean along with Standard Deviation (SD). Analysis of all data collected was done using SPSS version 18.0 (SPSS Inc., Chicago). P value ≤ 0.05 was regarded as significant statistically. Multiple variate repeat measure Analysis of Variance (ANOVA) was utilized to compare IP contrasts in 2 eyes at defined timepoints and GA amid examination period. The variates used are age or age-group, operation type, sex, right or left eye, and non-operated or operated eye. IP at various timepoints is taken as dependent variate. Tukey's honest significance test is utilized for post hoc analyses. Pearson's correlation coefficient is utilized for additional investigation of relation among heart rates, systolic blood pressures, and IPs'.

Results

Between May 2015 and October 2015, 120 children were selected in present cohort. Mean with Standard Deviation (SD) for age is 5.1 ± 2.2 y. Around 57.5% of patients were girls. Children were planned for strabismus operation (45.83%), lachrymal-duct operation (25.83%), and other non-intraocular surgeries (12.5%) etc. Table 1 depicted the planned operations in total number of patients. Around 75.83 % of patients categorized under ASA classification 1 while 24.16 % in classification 2. Children were categorized into 4 groups: AC (38, 31.6%); AD (19, 15.8%); BD (48, 40%); and BC (15, 12.5%), respectively.

Mean IP overall estimates were 6.9 ± 3.3 mmHg and were under normal distribution. No significant contrasts in IP with respect to operation type, sex, and right or left eye was noted. In respect to 4 defined timepoints, IP was noted to be 7.51 ± 2.74 mmHg amid GA1 with significant decrease (p<0.001) to 5.67 ± 2.98 mmHg amid GA2 and significant increase (p=0.011) to 6.96 ± 2.24 mmHg amid GA3 and further increase (p=0.042) to 7.95 ± 4.68 mmHg at GA4. No impact of age on IP was found with regards to age-groups (0 to 3, 4 to 7, 8 to 11 y). Be that as it may, in respect to the distinctive timepoints, patients under 0 to 3 y age were noted to experience significant (p<0.001) low IP amid GA4 than ones under 4 to 7 y.

Concerning the diverse subcategories, at GA1 IP was higher in BD category (7.6 ± 3.1 mmHg) while lower in AD category (5.9 ± 1.6 mmHg). Significant contrasts were not seen among subcategories. Amid GA2, significant decrease (p<0.05) in IP in all subcategories in comparison to GA1 was observed with lower IP at GA2 in BC category (4.2 ± 2.2 mmHg). During GA3, higher raise from GA2 to GA3 was observed in AC category. Significant contrasts were not seen among subcategories amid GA1, GA2, as well as GA3 in terms of

various kinds of GA. Amid GA4, IP was significant low in AC category than BD category ($p < 0.01$) and AD category ($p = 0.031$). Two subcategories maintained using propofol (BD as well as AD) demonstrated raise in IP significantly in GA4 when compared with GA1.

Analysis of haemodynamic characteristics and intraocular pressure at defined timepoints were depicted in Table 2. Heart rate as well as blood pressure showed significant decrease from GA1 to GA3 ($p < 0.05$), with raise significant from GA3 to GA4 ($p = 0.016$). Pearson's correlation coefficient of 0.19 for heart rate with GA2 ($p < 0.05$), 0.31 in case of blood pressure with GA2 ($p = 0.042$) while 0.28 in case of blood pressure with GA3 ($p < 0.001$) was noted.

Table 1. Planned operations in 120 Chinese children.

Name of operation	N (%)
Strabismus	55 (45.83%)

Table 2. Haemodynamic characteristics and intraocular pressure at defined timepoints.

Variables	GA1	GA2	GA3	GA4
Intraocular pressure, mmHg	7.51 ± 2.74	5.67 ± 2.98 ^a	6.96 ± 2.24 ^b	7.95 ± 4.68 ^c
Heart rate, BPM	109.92 ± 22.34	106.13 ± 24.62 ^a	99.26 ± 25.79	103.28 ± 22.19 ^c
Systolic blood pressure, mmHg	103.95 ± 16.22	96.10 ± 11.78 ^a	93.31 ± 8.83	96.21 ± 9.88 ^c

^aSignificant changes from GA1 to GA2; ^bSignificant changes from GA2 to GA3; ^cSignificant changes from GA3 to GA4.

Discussion

Raised IP is primary risk-factor of glaucoma and its development. The general IP values in adults' ranges from 10-21 mmHg. There is scarcity of solid information on IP level in pediatrics generally and under GA. As children don't comply much, IP measurements are mostly just practicable under GA. It's not clear till now, if these estimations speak to ordinary condition or should be redressed. Timepoints amid GA at which estimation is taken likewise gives off an impression of being a variable impacting IP. Estimations of IP with accuracy are vital in glaucoma patients. In line with our awareness, present study is the first one in China to research the topic, and it incorporates the biggest number of pediatrics with IP estimations at various timepoints amid anesthesia in non-intraocular surgeries in pediatrics with no glaucoma.

The outcomes demonstrate decline in IP significantly in pediatrics post GA inducing in all subcategories. No IP contrasts among subcategories at timepoints GA1, GA2 as well as GA3 were noted. Just AC category had significant low IP amid GA4 compared to 2 categories maintained utilizing propofol+remifentanil (BD and AD).

Many GAs reduce intra-cerebral pressure and correlation between IP and intra-cerebral pressure is familiar. Raise in depth anesthesia may cause IP decline also. Tracheal intubation is related to rise in IP because of sympathetic reaction. Prior reviews demonstrated that an expansion in IP could be avoided

Lachrymal duct	31 (25.83%)
Others	15 (12.5%)
Ptosis	4 (3.33%)
Excision of eyelid cysts	3 (2.5%)
Excision of eyelid tumors	3 (2.5%)
Removal of foreign bodies	2 (1.67%)
Excision of Chalazion	2 (1.67%)
Papillary conjunctivitis cryotherapy	1 (0.83%)
General exam using anesthesia	1 (0.83%)
Orbit biopsy	1 (0.83%)
Conjunctival synechiolysis	1 (0.83%)
Removal of corneal sutures	1 (0.83%)

utilizing remifentanil post administering succinyl choline and tracheal-intubation. Inhalation anesthetic agents of whom sevoflurane short of what others are familiar to raise IP, whereas propofol reduces IP. It's considered that propofol +remifentanil in case of inducing gives satisfactory intubation condition, averts IP raise, as well as haemodynamic stress reaction to laryngoscopy/intubation control [14,15]. In our study, patients were on laryngeal masks, as per latest measures, with a specific end goal to avert laryngeal trauma and incite low sympathetic-stimulation. A study by Watcha et al. revealed that raise in IP was low using laryngeal masks than tracheal intubations [16]. As a pre-medication, midazolam was administered orally as it doesn't have any impact on IP as per prior reviews [17].

Data on IP level post administering sevoflurane compared to propofol, two in remifentanil combination was present for adults' [18,19]. Information has likewise been reported on IP level post administering sevoflurane in pediatrics having suspected/diagnosed congenital/secondary glaucomas. In Germany, similar study was conducted by Termuhlen et al. [20,21]. As opposed to the discoveries of the present review in pediatrics, it was observed that propofol as well as sevoflurane lower IP similarly amid non-ophthalmic operation and recoveries of adults [18]. Schafer et al. revealed more prominent diminishment in IP amid GA using propofol compared to sevoflurane, two in remifentanil combination, in adults receiving cataracts operation with tracheal intubations,

recommending propofol as good at sympathetic reaction blockage amid tracheal intubations and extubations than sevoflurane [19].

In standard clinical practice, it's vital to be aware of IP value interpretations in pediatrics on GA for reliably made diagnosis concerning glaucoma, its development as well as therapy. Not only the types of anesthetics utilized, but the timepoint estimations might have IP impact significantly. Recently a review revealed significant high IP levels in pediatrics post laryngeal mask inclusion than prior to, however IP wasn't measured amid GA [22]. GA in review was elicited using propofol/sevoflurane with maintenance using sevoflurane. We contrasted IP at 4 specified estimation timepoints. IP levels varied prior and post GA induction as well as amid maintenance. It's elevated in all subcategories across GA2 (post induction) and GA3 (deeper anesthesia and post laryngeal mask inclusion). IP additionally demonstrated elevation across deeper anesthesia (GA3) as well as reversion post extubations (GA4). A diminishment in IP amongst GA3 and GA4 was just found in AC subcategory.

No significant contrasts in IP with respect to operation type, sex, and right or left eye was noted. No impact of age on IP was found with regards to age groups (0 to 3, 4 to 7, 8 to 11 y). However, in respect to the distinctive timepoints, patients under 0 to 3 y age were noted to experience significant ($p < 0.001$) low IP amid GA4 than ones under 4 to 7 y.

Certain intrinsic limitations require consideration while interpreting the study outcomes. Pediatrics was non-randomized which might be a conceivable selection bias. We enrolled pediatrics who were under ocular operation due to different reason and avoided those having glaucoma/it's suspects (cornea or bulbus enlargements). Although, in certain cases glaucoma isn't diagnosed around then and progresses late. Besides we incorporated ophthalmological cases and not the rest.

Conclusion

All in all, the study demonstrates significant reduction in IP by GA in pediatrics having no glaucoma history who underwent non-intraocular operation. No significant contrasts among subcategories at timepoints GA1 to GA3 was observed, however IP is fluctuating amid GA. Amid GA4, IP was significant low in AC category than BD and AD categories (two subcategories maintained using propofol). The IP variations in pediatrics under GA are distinctive to general IP values in adults' that ranges from 10-21 mmHg. Moreover, they fluctuate amid narcosis as found in this review. The outcomes could be extended to glaucoma patients. It's presumed that anesthetics option would have similar impact in glaucoma patients. This ought to be contemplated while estimating IP under GA.

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***Correspondence to**

Tieli Dong
Department of Anesthesiology
The Second Affiliated Hospital of Zhengzhou University
PR China