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Anesthetic complications during general anesthesia without intravenous access in pediatric ophthalmologic clinic: Assessment of 5216 cases

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Abstract

BACKGROUND—General anesthesia utilizing inhalational agents without intravenous (IV) access for minor procedures is controversial[1]. Eliminating IV access increases efficiency and patient satisfaction; however, the ability to introduce rapid acting medications into the circulation during an unanticipated emergency becomes challenging. The objective of this study was to examine complication risk following pediatric ophthalmologic examinations under anesthesia (EUA) without IV placement.

METHODS—A retrospective review of consecutive pediatric patients who underwent EUA for retinoblastoma management was performed from 2004 to 2014. The total number of anesthetics and elective IV placement were identified. Patient characteristics, length of the procedure, laryngeal mask airway (LMA) placement, and complications were also recorded. A survey of specialized ophthalmology institutions was performed in order to ascertain the state of standard practices.

RESULTS—Over 10 years, 5,216 anesthetics were identified. The mean age and weight of the patients were 2.7± 2.0 years and 14.4 ± 6.6 kg, respectively. In all, 298 elective IVs were placed (6%) and 4,918 cases (94%) were performed without IV access. A total of 1,687 (32%) anesthetics were administered with a laryngeal mask airway (LMA), of which 1,389 (82%) did not have IV access. There were no deaths and no unplanned admissions. There were 8/5216 complications (0.153%) which all resolved safely.

CONCLUSIONS—The current study shows that it is safe to perform EUA and procedures for the diagnosis and treatment of retinoblastoma in pediatric patients without securing IV access. All

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Congresses. – None

emergency post-complication IV placements were successful and no long-term sequelae were seen.

Keywords

Pediatrics; anesthesia; intravenous; complications; retinoblastoma

Introduction

The question of whether intravenous (IV) access is essential for all anesthesia procedures is an on-going debate.[1] IV placement can be difficult in pediatric patients due to smaller veins, body habitus and excessive subcutaneous fat. However, IVs can be important for administering essential drugs and fluids during unpredictable emergencies such as laryngospasm, bronchospasm, anaphylaxis, arrhythmias, excessive blood loss and other complications.[1]

In the pediatric patient population requiring ophthalmologic oncology services at our institution, the most common intraocular tumor encountered is retinoblastoma. Ophthalmologic examinations under anesthesia (EUA) are necessary for pediatric patients because of lower cooperation in children and the associated discomfort from a comprehensive eye examination. Most patients return for an EUA every 4 to 6 weeks for at least one year. Increased attempts for IV placement causes financial inefficiencies and waste in the health care system. Goff et al analyzed 1135 peripheral IV attempts for pediatric patients and found that the 28% of patients requiring 3 IV attempts consumed 43% of the group's total costs[2]. Therefore, forgoing IV placement can result in considerable cost savings, as well as reduced discomfort to the pediatric patients.

Several studies have espoused the safety of performing general anesthesia without IV access for minor procedures in the operating room (OR). In 2007, Allen[3] compared two patient groups with and without IV access prior to myringotomy and found no complications associated with the lack of IV access. In addition, he showed a reduced time under anesthesia of almost 3 minutes. Haupert et al[4] examined parental satisfaction for myringotomies in children with or without IV access. Parental satisfaction for patients without IV access was significantly higher than those with IV placement (95% vs. 28%). Another retrospective study from the United Kingdom (UK) evaluated the safety of dental extraction procedures with no IV access in over 6,440 children over a 5 year period. The authors found no emergencies during any of these procedures requiring intravenous access or intubation.[5] More relevantly, Vigoda et al[6] performed a retrospective study of 3,196 ophthalmologic examinations under anesthesia, where the majority (92%) did not have IV access, and concluded that it was a safe practice.

However, despite these studies, there is still no consensus on whether IV placement is always necessary during general anesthesia, especially for children. In a 2012 survey of 727 practicing anesthesiologists in the UK, only 42% of the respondents reported ever having placed patients under general anesthesia without IV access, with 84.7% of them stating that this is a rare event. Only 13 of 727 (1.8%) respondents indicated that they would perform general anesthesia in children for an EUA without IV access. The majority stated that there

would be no situation in which they would even consider it.[7] The controversy regarding the safety of general anesthesia without IV access outside of the operating room environment is exacerbated by the relative paucity of clinical data and the diverse types of relevant procedures.

Our retrospective study of pediatric patients from the ophthalmologic oncology service seeks to demonstrate the safety and efficiency of performing EUA in conjunction with adjuvant procedures such as cryotherapy, laser treatment and intraocular chemotherapy injections without securing IV access in the ophthalmology clinic.

Materials and methods

IRB/Consent

Institutional Review Board approval at Memorial Sloan Kettering Cancer Center (MSKCC) was obtained for this study. Patient consent was not required per MSKCC IRB since this is a retrospective chart review study.

The authors retrospectively reviewed the anesthesia records and surgical consultation documentation of all pediatric patients coming to the ophthalmology oncology clinic from January 2004 to January 2014. Only patients that underwent ocular EUA were included in this study. Procedures often performed concurrently with the EUAs include ultrasonography, photography of fundus, laser treatment, cryotherapy treatment, periorbital chemotherapy injection, intravitreal chemotherapy injection, electroretinography, and fitting of ocular prosthesis following enucleation. No patient encounter was excluded.

Anesthesia services were provided utilizing the anesthesia team model approach. An attending anesthesiologist medically directed either a certified registered nurse anesthetist (CRNA) or an anesthesia resident for all cases. Only a select group of attendings and CRNAs are assigned to the ophthalmology clinic on a regular basis.

The set-up for the pediatric ophthalmic oncology clinic at our institution is unique. The clinic has a child-friendly waiting area, an exam room in a large environment with no windows to ensure darkness when necessary, and an adjoining pre-operative room for screening patients the day prior. Despite not being topographically connected to any of our OR suites, all the necessary equipment to safely anesthetize patients is available in the clinic’s exam room, including an anesthesia machine and appropriate scavenging system. All airway management is performed by CRNAs or residents with the supervision of an anesthesiologist. All patients receive inhalation induction with sevoflurane. Anesthesia is maintained with sevoflurane via mask or laryngeal mask airway (LMA). Some patients receive elective IVs because of administration of antiemetics, parental preference for propofol or to undergo Fluorescein angiogram. Analgesia for painful procedures is provided by rectal acetaminophen. Patients also recover in this exam room, allowing the anesthesiologist to monitor both the anesthetized child currently being examined and the recovering child with the help of a CRNA or resident and a pediatric recovery room nurse. No board certified pediatric anesthesiologist were employed by the institution at this clinic.

For this retrospective study, the anesthesia record and the surgical documents were reviewed for each anesthesia encounter. Parameters extracted include date of anesthesia, birth date, weight, gender, ASA class, duration of anesthesia, induction type, use of LMA, availability of IV access, necessity of intubation and procedures conducted. Complications were considered as any deviations from the anesthesia plan. All recorded complications were individually analyzed.

Furthermore, in order to gain insight into other retinoblastoma groups' anesthesia practices, a survey was sent to 22 centers known for their work with retinoblastoma. The survey included 21 questions regarding the perioperative experience for patients undergoing EUA, specifically in regards to setting, type of anesthesia, airway device, intravenous placement and medications given. The survey was emailed to physicians at each institution. Results were recorded using Survey Monkey® (Palo Alto, Ca), a web based survey platform.

Results

The number of unique patients reviewed was 512. Recurrent examinations are necessary for this patient population to monitor retinoblastoma progression, so the actual total number of anesthetic encounters reviewed was 5,216, with a mean of 10.2 exams per patient.

The general characteristics of the pediatric patients and their anesthesia procedures are shown in Table 1. Of the 5,216 EUAs, 917 were performed concurrently with another diagnostic or treatment procedure. The most common adjuvant procedures were electroretinography (917), laser treatment (559), cryotherapy (267), intravitreal injection (107) and angiogram (73).

The vast majority of patients (94%) did not have an elective IV placed (Table 1). There was a trend of higher IV placement incidence associated with prolonged procedures (Table 2). The majority of the EUA and associated procedures were performed within 30 minutes (74.3%). A total of 1,687 (32%) anesthetics were administered with a laryngeal mask airway (LMA), of which 1,389 (82%) did not have IV access.

When reviewing the 5,216 cases, 8 complications were noted as seen in Table 3. The overall incidence rate for complications was 0.153% (8/5126). All complications were successfully rectified with no long-term sequelae.

There were three cases of laryngospasm. Of these, one required intubation (# 3), one required positive pressure ventilation by face mask with 100% oxygen (# 2), and for the last one, an IV was started and succinylcholine and glycopyrrolate administered after positive pressure ventilation with 100% oxygen was unable to overcome the laryngospasm. During the period of laryngospasm the desaturation period was not long enough to be recorded in the anesthesia record, so we do not have any data on the depth and duration of desaturation.

Two complications were due to excessive secretions (#7 and #8). In case #8, IV glycopyrrolate was necessary in addition to suctioning, while case # 7 resolved with suctioning alone. No incidence of pulmonary aspiration was noted in any of the anesthetic records.

The patient in case # 3 stabilized after intubation and was successfully extubated at the end of the procedure, without any further complications. For the patient in case # 5, the difficulty in breathing resolved after an IV was placed, glycopyrrolate administered and suctioned. In case # 4, the placement of an LMA caused the development of a bronchospasm. The LMA was removed, the anesthetic deepened, leading to resolution of the bronchospasm. At this time the LMA was reinserted without any further complications.

Eight centers responded to our survey and these responses are summarized in Tables 4 and 5, with the authors' institutional practice shown as comparison. Notably, 7/8 centers performed EUA in the OR while only 1 did so in either the OR or procedure room. All performed EUA as same day surgery. Only in the case of already hospitalized premature infants or in the rare event of a complication are patients admitted following the exam. The majority of centers report not placing an IV at all during anesthesia (5/8 centers). Of the 3 that do, the IV is placed after induction. With our institution included, 2/3 of institutions examined do not electively obtain IV access. Sevoflurane is used for maintenance at all centers. The majority of institutions have board certified pediatric anesthesiologists performing the anesthetic (6/8 centers) versus non-specialized anesthesiologists (2/8 centers). When comparing elective IV placement between the two types of centers, board certified pediatric anesthesiologist were less likely to place an IV electively (4/6 centers) compared to centers with non-specialized anesthesiologists (1/2 centers). The majority of institutions surveyed allow parents of the patients into the induction room, but none allowed the parents to stay for the entire procedure. No mortalities were reported by any of the centers. Only two institutions reported unplanned admissions; one was due to a case of aspiration and the other due to a patient's allergic reaction to chemotherapy injection. Both complications occurred at institutions that report placement of IV after induction.

Discussion

The argument of placing an IV for all anesthetic procedures stems primarily out of fear of not being able to react immediately with rapid acting pharmacological agents in case complications such as laryngospasms, anaphylaxis and pulmonary aspiration arise. It is also an important route for analgesics and antiemetics.[1]

The total risk of complication was determined to be 0.153% in this study. The low risk for complications is consistent with the current literature. Vigoda et al reported on 3,196 pediatric ophthalmologic procedures, of which 92% were without IV, and no adverse events resulted[6]. When reviewing the 5,216 cases in this study, 8 complications were noted. All complications were successfully rectified with no long-term sequelae. Of the 8 complications, in 2 of the cases (# 3 and # 6), IV access was already available prior to the complication, while in 1 (# 7), IV access was not necessary. Peripheral IV access was obtained in the remaining 5 of 8 cases after complications arose with a success rate of 100%. The ophthalmology clinics surveyed in this study also reported similarly low risks of complications, with only 2 of 8 sites noting complications of an aspiration and an allergic reaction.

In scenarios of difficult intravenous access, there are alternatives such as intramuscular and intraosseous routes. While pharmacokinetics of intramuscular administration of medications is unpredictable and usually characterized by a slow onset of action, the intraosseous alternative has been shown to compare favorably with central or peripheral intravenous injections with few reported complications. In 2013, Hamed et al[9], reported their experience in utilizing intraosseous access to the systemic venous circulation in 30 pediatric patients, with the majority in emergency surgeries. All intraosseous access attempts were achieved within two minutes successfully. Orlowski et al[10] demonstrated the equivalency in terms of drug and fluid delivery between intraosseous, central intravenous and peripheral intravenous routes.

In an emergency, succinylcholine is often the first-line drug for dealing with laryngospasms.[11] Tobias and Nichols[12] documented two emergency pediatric cases where intraosseous succinylcholine was injected due to failed peripheral IV access. For both, muscle relaxation occurred within 45 seconds to facilitate orotracheal intubation. Katan et al[13] also reported a case in which failed IV access prompted intraosseous injection of lidocaine, thiopental sodium and succinylcholine which resulted in muscle relaxation within 60–70 seconds. While the most commonly observed complication of intraosseous infusion is osteomyelitis, it has been reported to occur with an incidence rate of 0.6% in a study of 4,000 reported cases.[14] Therefore, the intraosseous route is relatively safe as an emergency procedure. Combined with the efficiency of intraosseous infusion as a route for drug delivery, the lack of IV access is less crucial, since in emergency situations, intraosseous access can be established rapidly.

Intravenous access, when available, is also often used for delivery of analgesics. There are, however, alternatives available. It is common practice at our clinic to administer rectal acetaminophen for pain treatment and this has been effective in our experience. In a study by Gandhi et al, a single dose of acetaminophen applied rectally proved to be an effective method of pain control following pediatric ophthalmic surgeries.[15] IV placement itself can be a source of pain. In a survey of infants and parents following myringotomies, the group without IV exhibited greater satisfaction and lower pain scores than those with IV placement.[4] The results of our survey also suggest that pain management was successful in other institutions where routine IV is not placed, as seen in Table 5. Therefore, we believe that IV access for the purpose of administering analgesic drugs is not typically necessary for EUA and similar procedures.

Forgoing IV placement also results in timesaving. According to this study, there is a correlation between IV access and longer anesthetic times. Specifically, 1.6% of the patients had an IV when the procedure was less than 15 minutes, as opposed to 19.3% of the cases over 60 minutes. This result is consistent with the existing literature. In particular, Haupert et al[4] showed that patients without IV placement spent less time in the hospital following myringotomy compared to those with IV (88 min vs 118 min).

Survey results indicated that 62.5% of the institutions do not place IV lines during EUA. This demonstrates that our institution is not alone in this practice, although previous literature suggests that forgoing IV is not an established standard among anesthesiologists.

The results of our survey are in stark contrast with a 2012 study showing only 13 of 727 (1.8%) surveyed anesthesiologists stating that they would perform general anesthesia in children for an EUA without IV access[7]; if our center is added to the survey results we demonstrate that 2/3 perform ophthalmologic exams and minor procedures without obtaining IV access. It is even more interesting that the surveyed institutions had eclectic international backgrounds, including Europe, South America, and North America, which minimizes the chance this could be a regional trend. The few complications in this study combined with the survey results suggest that this may be considered a safe standard of care, especially supported by the relatively higher prevalence of this practice among the centers with pediatric anesthesiologists (4/6 centers) surveyed. The paucity of complications reported by the institutions, except for 2 occurrences at 2 centers, provides further evidence pointing to the safety of the practice. The value of forgoing an IV is evident considering that all responding centers perform EUAs as an ambulatory procedure and require quick turnover and recovery. The most notable difference found when comparing our institution to the centers surveyed is that 7 of 8 institutions still perform EUAs and procedures in the operating room. In contrast, a unique part of the practice at MSKCC is the transfer of EUA and related procedures to a clinic environment topographically separated from the OR, making this to our knowledge, the first high volume study reviewing a clinic based pediatric practice, where general anesthesia is routinely done without obtaining IV access. All previous studies that advocate the use of general anesthesia without the placement of an intravenous are based on practices in the OR[4,6]. In contrast, our modus operandi has been very successful among patient and families because the clinic setting reduces the amount of time the children have to spend at the hospital. This setting permits us to perform approximately 45 EUA procedures per week with the clinic operating 3 days per week.

There are some limitations to this study. First, it was not possible to compare the incidence of complications for with IV access against those without, because of the low number of complications. Second, even though 32% of the cases reviewed in this study had LMA placement, and based on the survey data, 4 of the 8 centers reported regular utilization of supraglottic airway devices, the effect of an LMA on the complications rate could not be determined due to the low incidence of complications. Nevertheless, it is notable that for 7 of the 8 complications, the patient had a LMA placed prior to the complication. Paradoxically, there are studies that report a lower risk of laryngospasm and other airway complications with LMA placement compared with endotracheal intubation.[16] Others however, have also reported that there is no significant difference in terms of complication rates between using a LMA or endotracheal tube to secure the airway.[17] In general, the LMA is accepted as a safe and easy tool for airway management.[18] In addition, the LMA may have been used in our clinic primarily when adjuvant treatment procedures were performed. It was not possible to evaluate this decision process retrospectively. These associated procedures, which potentially cause a longer duration of anesthesia, may contribute more to the occurrence of the complications than the LMA per se.

Despite these limitations however, in our opinion, the combination of the low incidence rate of complications at 0.153%, and the availability of options to infuse drugs and fluids via intramuscular and intraosseous routes make EUA procedures without IV placement a safe undertaking. Each of the 8 complications were resolved without long term sequelae and IV

access was obtained successfully. Furthermore, since all of the complications were airway-related in nature, resolution was achieved in most cases without administering IV medications, rendering the IV placement not absolutely essential for safe outcomes.

Conclusions

Although general anesthesia without IV access remains controversial, there is a growing body of literature affirming its safety for select procedures. This 10-year review of 5,216 cases yielded a complications incidence rate of 0.153%. The results confirms the safety of outpatient EUA without obtaining IV access even in a clinic setting. All emergency IV placements were successful and no complications resulted in long-term sequelae. At our institution, we have a specialized care team that maintains good communication with the ophthalmology team and the patients' family. This, combined with experience gained from the high volume of cases performed make our approach successful.

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Key Messages

- Pediatric procedures such as ophthalmologic examinations under anesthesia may be performed safely, with low risk of complications without peripheral intravenous access.
- Forgoing intravenous access can result in cost and time savings, as well as greater satisfaction for patients and parents.
- As shown by the survey and results of this study, forgoing intravenous access placement for select pediatric procedures may be considered to be a safe standard of care.

Table 1

General Characteristics

Age (mean year ± SD)	2.7 ± 2.0
Weight (mean kg ± SD)	14.4 ± 6.6
Gender (Female %: Male %)	46%:54%
Anesthesia Duration (mean minutes ± SD)	24 ± 16
Diagnosis	
Retinoblastoma	98%
Others	2%
ASA Class	
1	502 (9.6%)
2	3592 (68.9%)
3	1034 (19.8%)
Unknown	88 (1.7%)
IV Placement	
Yes	298 (6%)
No	4918 (94%)
LMA Placement	
Yes	1687 (32%)
No	3529 (68%)

SD = standard deviation, IV = intravenous line, LMA = laryngeal mask airway, ASA[8] =American Society of Anesthesiologists. Other diagnoses include Coats' Disease, persistent hyperplastic primary vitreous, or incontinentia pigmenti, among others.

Table 2

Anesthesia Duration and IV Placement

Duration of Anesthesia	Anesthesia Encounters (%)	Percent with IV Placed
≤ 15 min	2097 (40.2%)	1.6%
15 – 30 min	1778 (34.1%)	4.3%
30 – 45 min	832 (16%)	12.1%
45 – 60 min	323 (6.2%)	18.0%
> 60 min	145 (2.8%)	19.3%
Unknown	41 (0.8%)	2.4%

Table 3

Cases of complications during EUA and other procedures

Case No.	Age (yr)	Weight (kg)	ASA Class	Cause/ Symptoms	Method of Resolution	IV Access[a]	LMA Placement[a]	Anesthesia Duration (min)	Concurrent Adjuvant Procedure
1	0.9	N/A	3	Laryngospasm	IV - Succinylcholine	Post	Prior	89	ERG
2	0.9	8.6	3	Suspected laryngospasm	Positive pressure mask (100% O2)	Post	Prior	35	Laser
3	1.3	6.37	3	Unable to ventilate	Intubation	Prior	Prior	37	ERG
4	1.7	14	2	Bronchospasm	LMA (removed + replaced)	Post	Prior	72	None
5	2	11.25	2	Breathing Diffusely; Chest Tight	IV - glycopyrrolate	Post	Prior	80	Laser
6	2.6	13.5	2	Laryngospasm	Intubation	Prior	Prior	35	Laser
7	3.3	15.5	2	Cough, excessive secretions	Suction	No	Prior	40	ERG
8	5.6	21	3	Copious secretions	Suction; IV glycopyrrolate	Post	No	19	None

[a]Prior = placed before complication; Post = placed after complication; ERG = electroretinography

Table 4

Survey Responses: Anesthesia Parameters

esponder ID	Anesthesia Type for Pediatric EUA	Type of Airway Devices Used					IV Access	
		Mask	Endotracheal Tube	Supraglottic Device	Nasal Cannula	Other - Oral Cannula (Guedel)	Placed?	Prior to or after induction
1	General Anesthesia	x	x	x	x		No	-
2	General Anesthesia	x					No	-
3	General Anesthesia		x	x			Yes	After
4	General Anesthesia		x				No	-
5	General Anesthesia					x	No	-
6	General Anesthesia			x			Yes	After
7	General Anesthesia		x	x			Yes	After
8	General Anesthesia	x					No	-
9	General Anesthesia	x		x			No	-

Responder ID: (1) Bascom Palmer Eye Institute, USA; (2) Miami Children's Hospital, USA; (3) Retinoblastoma Center of Houston-MDACC/TCH/Baylor/Methodist, USA; (4) VU University Medical Center, Netherlands (5) Centro Infantil Boldrini, Brazil; (6) Wills Eye Hospital, USA; (7) Hôpital Jules Gonin, Switzerland; (8) Murray Ocular Oncology and Retina, USA; (9) Memorial Sloan Kettering Cancer Center, USA – Authors' Institution

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Table 5

Survey Responses: Pain Management Procedures

Responder ID	Cryotherapy		Laser Therapy		Intravitreous Injections	
	Pain Medication Administered?	Type of Pain Medication	Pain Medication Administered?	Type of Pain Medication	Pain Medication Administered?	Type of Pain Medication
1	N/A	-	Yes	NSAIDS; Narcotics	Yes	NSAIDs; Narcotics
2	No	-	No	-	No	-
3	Yes	Narcotics	No	-	No	-
4	Yes	Narcotics; IV Paracetamol	Yes	Narcotics; IV Paracetamol	N/A	-
5	Yes	Rectal/IV Dipirona	Yes	Rectal Dipirona	N/A	-
6	Yes	NSAIDS; Narcotics	Yes	NSAIDS; Narcotics	Yes	NSAIDs; Narcotics
7	Yes	NSAIDS; Narcotics	Yes	NSAIDS; Narcotics	Yes	NSAIDS
8	No	-	No	-	No	-
9	Yes	Rectal Acetaminophen	Yes	Rectal Acetaminophen	-	-

Responder ID: (1) Bascom Palmer Eye Institute, USA; (2) Miami Children's Hospital, USA; (3) Retinoblastoma Center of Houston-MDACC/TCH/Baylor/Methodist, USA; (4) VU University Medical Center, Netherlands (5) Centro Infantil Boldrini, Brazil; (6) Wills Eye Hospital, USA; (7) Hôpital Jules Gonin, Switzerland; (8) Murray Ocular Oncology and Retina, USA; (9) Memorial Sloan Kettering Cancer Center, USA – Authors' Institution