Ketamine and Intraocular Pressure in Children

Shernaz Wadia, MD, MSc*; Rahul Bhola, MD; Douglas Lorenz, PhD; Pradeep Padmanabhan, MD, MSc; Joshua Gross, BS; Michelle Stevenson, MD, MS

*Corresponding Author. E-mail: sawadi01@louisville.edu.

Study objective: We determine the increase in intraocular pressure during pediatric procedural sedation with ketamine, and the proportion of children whose increase might be clinically important (at least 5 mm Hg).

Methods: We prospectively enrolled children aged 8 to 18 years, chosen to receive ketamine sedation in a pediatric emergency department. We measured intraocular pressure before sedation, immediately after ketamine administration, 2 minutes post–drug administration, and every 5 minutes thereafter until recovery or 30 minutes after the final dose. We descriptively report our observations.

Results: For the 60 children enrolled, the median intraocular pressure increase was 3 mm Hg (range 0 to 8 mm Hg). Fifteen children had a brief greater than or equal to 5 mm Hg increase in intraocular pressure from baseline.

Conclusion: In this study of ketamine sedation in children with healthy eyes, we observed mild increases in intraocular pressure that at times transiently exceeded our bounds for potential clinical importance (5 mm Hg). [Ann Emerg Med. 2014;64:385-388.]

Please see page 386 for the Editor's Capsule Summary of this article.

A **podcast** for this article is available at www.annemergmed.com.

0196-0644/$-see front matter

http://dx.doi.org/10.1016/j.annemergmed.2014.01.029

INTRODUCTION

Background

Ketamine, a widely used agent for emergency department (ED) pediatric procedural sedation, is sympathomimetic and often increases pulse rate and blood pressure. It can also elevate intraocular pressure[1] either as a result of general blood pressure elevation or tension in the extraocular muscles.[2] Two recent ED studies have shown minimal increases in intraocular pressure with ketamine.[3,4] However, the first was potentially confounded by the midazolam coadministered in the majority of children,[3] and the second obtained baseline intraocular pressure measurements just after (rather than before) ketamine administration.[4]

It is known that in healthy eyes, 10 mm Hg increases in intraocular pressure reduce ocular fundus pulsations and decrease choroidal blood flow and that in injured eyes, small pressure increases may lead to choroidal or optic nerve head ischemia.[5] Two previous studies have defined a transient increase of 3 to 5 mm Hg in intraocular pressure as clinically important in previously damaged eyes.[6,7]

Importance

If ketamine causes clinically important elevations in intraocular pressure, then it should be avoided in patients with ocular pathology.

Goals of This Investigation

Our primary objective was to evaluate the increase in intraocular pressure during pediatric procedural sedation with ketamine. Our secondary objectives were to determine the proportion of children whose increase might be clinically important (≥5 mm Hg), determine the absolute maximum pressures, and contrast clinical features in those with and without clinically important increases.

MATERIALS AND METHODS

Study Design and Setting

We performed this prospective observational study at the Kosair Children's Hospital ED. We received approval from the institutional review board at the University of Louisville. We obtained written, informed consent from parents and assent from the children.

Selection of Participants

We enrolled children aged 8 to 18 years and receiving procedural sedation with intravenous ketamine, with our convenience sampling based on the availability of the principal investigator. We excluded children with predispositions to intraocular pressure elevation (neurofibromatosis, Sturge-Weber syndrome, and diabetes mellitus); those with previous eye surgeries; parents with congenital glaucoma; medications that

Editor's Capsule Summary

What is already known on this topic

Ketamine is sympathomimetic and can increase intraocular pressure.

What question this study addressed

How much does ketamine increase intraocular pressure?

What this study adds to our knowledge

In this trial of 60 children with healthy eyes and undergoing ketamine sedation, serial measures of intraocular pressure demonstrated increases that were mild (median 3 mm Hg; range 0 to 8 mm Hg) and transient.

How this is relevant to clinical practice

Ketamine-induced elevation of intraocular pressure is of unlikely clinical importance in children with healthy eyes.

increase intraocular pressure (eg, inhaled, ocular, or systemic steroids); eye injury requiring ophthalmology consultation; head trauma requiring neurosurgery consultation; sedation for a procedure that requiring draping of the eyes; developmental delay rendering the patient uncooperative with ocular measurements; previous adverse reactions to tetracaine, topical anesthetics, aminobenzoic acid, or latex; and guardians or patients unable to speak English.

Study investigators, previously trained by a pediatric ophthalmologist, measured intraocular pressure in each eye with a Tono-Pen (Reichert Inc, Buffalo, NY) after anesthetizing the corneas with 1 to 2 drops of tetracaine. Three to 6 acceptable readings were averaged, and the final value was displayed in millimeters of mercury on a digital display. If the device's reported coefficient of variation was 20% or higher, the measurement was not recorded and another Tono-Pen measurement was taken.

The Tono-Pen is widely regarded as an accurate tool, with 71% of readings within 2 mm Hg (SD).[8] Tetracaine ensures comfort and mitigates eyelid squeezing, which can falsely elevate the measurement.[9]

Before sedation, study investigators obtained a baseline validated verbal numeric pain score (0=no pain to 10=the most intense pain imaginable).[10] Children were monitored according to the guidelines for pediatric procedural sedation provided by the American Academy of Pediatrics,[11] and we recorded depth of sedation with a modification of the University of Michigan Sedation Score (Appendix E1, available online at http://www.annemergmed.com).[12] Ketamine was administered at a target rate of 0.5 mg/kg per minute.

We measured intraocular pressure before sedation, immediately after the initial dose of ketamine and saline solution flush were administered, 2 minutes postinfusion, and every 5 minutes postinfusion, up to 30 minutes after the last ketamine dose or until the sedation score was 0 or 1. We recorded vital signs and sedation score at each such measurement and judged the degree of eyelid squeezing as none, mild, moderate, or excessive.

Table 1. Patient characteristics.*

Sex	
Male	49 (82)
Female	11 (18)
Race	
White	44 (73)
Black	11 (18)
Other	5 (8)
Indication for sedation	
Upper extremity fracture	51 (85)
Lower extremity fracture	7 (11.7)
Shoulder dislocation	2 (3.3)
Medical history	
Previously healthy	48 (72)
ADHD	8 (13)
Asthma	3 (5)
Other conditions	6 (10)
Home medications	
Yes	45 (75)
No	15 (25)
Age, y	11 [8, 17]
Weight, kg	47 [25, 104]
Pain score, 1–10	6.5 [2, 10]
Ketamine administration	
First dose, mg/kg	1.39 [0.62, 2.20]
Cumulative dose, mg/kg	1.48 [0.62, 3.77]
Other medications	
Ondansetron	39 (65)
Morphine	29 (48)
Oxycodone	22 (37)
Midazolam	2 (3)
Fentanyl	2 (3)
Ibuprofen	2 (3)
Diphenhydramine	1 (2)
Ropivicaine	1 (2)
Diazepam	1 (2)
Cefazolin	1 (2)
Eyelid squeezing	
Overall	48 (80)
During maximal intraocular pressure	9 (15)

	Preketamine	**At ketamine dose**
Systolic blood pressure, mm Hg	128 [91, 161]	134 [94, 174]
Diastolic blood pressure, mm Hg	74 [47, 128]	83 [53, 106]
Respiratory rate, breaths/min	18 [10, 30]	20 [7, 36]
Pulse rate, beats/min	91 [61, 137]	108 [65, 147]
Oxygen saturation (%)	98 [96, 100]	98 [92, 100]
Intraocular pressure, mm Hg	17 [11, 19]	17 [12, 25]

*Values are No. (%) for categorical variables and median [min, max] for continuous variables.

Outcome Measures

Our primary outcome was the maximum intraocular pressure change observed during the course of observation. Our secondary outcomes were the occurrence of a potentially clinically important increase in intraocular pressure (≥5 mm Hg),[6,7]