The Effect of Ketamine on Intraocular Pressure in Children

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Background
- Procedural Sedation (PS) is commonly utilized in the Pediatric Emergency department to decrease the level of consciousness to obtain cooperation and comfort
- Ketamine is a dissociative anesthetic which induces sedation, amnesia, and analgesia. A reported adverse side effect of ketamine is elevated intraocular pressure (IOP)\(^1\)
- Ketamine may increase IOP either by an increase in blood flow secondary to elevated blood pressure or tension in the extra-ocular muscles\(^2\)
- Understanding ketamine’s effect on IOP will improve knowledge of the safety of ketamine during pediatric PS

Objective
To evaluate the maximum change in IOP during pediatric PS with ketamine, estimate the proportion of children with maximum increase in IOP ≥ 5 mm Hg and determine any dose response relationship between ketamine and change in IOP

Methods
- Prospective, observational study
- Enrolled children (8-18 years of age) undergoing PS with intravenous ketamine
- IOP was measured in each eye using tonometry with a Ton-Pen® which in previous reports had 71% of the readings within ± 2 mm Hg
- Baseline IOP measurements were taken (within a coefficient of variance) prior to ketamine administration and immediately after the initial dose of ketamine, 2 minutes post infusion, and every 5 minutes up to 30 minutes after the last ketamine dose or until the sedation score was 0 or 1 according to the modified Michigan Sedation Score (UMSS)\(^4\)
- Date of birth, sex, race, past medical history, indication for sedation, and dosages for all administered medications were recorded

Data Analysis:
- The outcome variable was maximum change in IOP from baseline
- A mean maximum change of 5 mm Hg or more considered significant
- The average maximum change in IOP with 95% normal confidence intervals was calculated
- The proportion of patients that exceeded an IOP change of 5 mm Hg at any time in either eye over the 30-minute observation period was calculated using Clopper-Pearson 95% confidence interval
- Relationship between maximum IOP change and cardiovascular parameters and maximum IOP change and ketamine dose

Table 1: Patient Characteristics

<table>
<thead>
<tr>
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<th>Mean ± SD</th>
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<tbody>
<tr>
<td>Age</td>
<td>11.3 ± 2.6</td>
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<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>49 (82%)</td>
</tr>
<tr>
<td>Female</td>
<td>11 (18%)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>44 (73%)</td>
</tr>
<tr>
<td>Black</td>
<td>11 (18%)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (8%)</td>
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<tr>
<td>Weight (kg)</td>
<td></td>
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<tr>
<td></td>
<td>50 ± 20</td>
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<tr>
<td>Pain Score (1-10)</td>
<td>6.7 ± 2.3</td>
</tr>
<tr>
<td>Ketamine Dose (mg/kg, 1st dose)</td>
<td>1.27 ± 0.22</td>
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<tr>
<td>Cumulative Ketamine Dose (mg/kg)</td>
<td>1.51 ± 0.49</td>
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Table 2: Correlation Coefficients with Maximal IOP

<table>
<thead>
<tr>
<th>Linear Model with Adjusted mg/kg/min and Cumulative Ketamine Dose</th>
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<tbody>
<tr>
<td>Pain Score</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Pre-Sedation SBP</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Pre-Sedation HR</td>
<td>0.28</td>
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Results
- Mean IOP\(_{max}\) was 19.4 [18.9, 20.0] with values ranging form 14 to 25
- Fifteen patients (25% [95% CI:15.18, 38]) exhibited a ≥ 5 Hg increase in IOP
- An initial correlation analysis showed that most of the clinical characteristics were at best weakly correlated with maximal IOP with the most significant correlation being pain score
- The mean pain score prior to sedation for those with ≥5mm Hg increase in IOP was 5.2 ± 2 compared to 7.2 ± 2.3 for those without a significant change in IOP
- A benzodiazepine was administered with ketamine in 3 study patients; none experienced a ≥5 mm Hg increase in IOP
- ≤25% of the patients showed maximal IOP changes immediately after ketamine administration

Limitations
- Other medications such as narcotics may have also effected IOP
- Eyelid squeezing may have falsely increased the baseline IOP
- IOP values were not obtained continuously

Conclusions
- Ketamine administration during procedural sedation is associated with a significant increase in IOP in significant proportion of children, particularly in the setting of lower baseline pain scores
- Maximal IOP generally occurs early and is associated with a concomitant increase in SBP
- These results differ from recent studies that found that ketamine was not associated with a significant increase in IOP\(^6\)

Acknowledgments
We would like to thank Kendra Sikes, Dr. In Kim, and Josh Gross for assistance with this study.

References