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Comparison of Propofol/Fentanyl Versus Ketamine/Midazolam for Brief Orthopedic Procedural Sedation in a Pediatric Emergency Department

Sandip A. Godambe, MD, PhD*; Vanessa Elliot, PhD‡; Dana Matheny, RN*; and Jay Pershad, MD*

ABSTRACT. Purpose. To compare the effectiveness of 2 medication regimens, propofol/fentanyl (P/F) and ketamine/midazolam (K/M), for brief orthopedic emergency department procedural sedation. This study was powered to compare recovery times (RT) and procedural distress as measured by the Observational Score of Behavioral Distress-revised (OSBD-r; range: 0–23.5 with 23.5 representing maximal distress).

Methods. We conducted a prospective, partially-blinded controlled comparative trial comparing intravenous P/F with K/M in a convenience sample of 113 patients aged 3 to 18 years old undergoing orthopedic procedural sedation. All medications were administered by the intermittent intravenous bolus method. An independent sedation nurse recorded total sedation time and RT. Effectiveness was measured using 6 parameters: 1) patient distress as assessed by independent blinded observers after videotape review using the OSBD-r; 2) orthopedic satisfaction score (Likert scale 1–5); 3) sedation nurse satisfaction score (Likert 1–5); 4) parental perception of procedural pain using a 0 to 100 mm Visual Analog Scale with the upper limit being “most pain”; 5) patient recall of the procedure; and 6) 1 to 3 week follow-up.

Results. RT and total sedation time were significantly less in the P/F group than in the K/M group (33.4 minutes vs 23.2 minutes). The mean OSBD-r scores during manipulation were 0.084 and 0.278 for the K/M and P/F groups, respectively. Although this difference was statistically significant (95% confidence interval for the mean difference −0.34 to −0.048), both regimens were successful in keeping the scores low. There was no statistical difference between the groups in the other measures of effectiveness. There was a statistically significant difference between the groups in the occurrence of desaturation and late side effects.

Conclusions. RT with P/F is shorter than with K/M. P/F is comparable to K/M in reducing procedural distress associated with painful orthopedic procedures in the pediatric emergency department. Although propofol has a greater potential of respiratory depression and airway obstruction as compared with ketamine, it offers some unique advantages including a quicker offset and smoother recovery profile. Pediatrics 2003;112:116–123; propofol, fentanyl, ketamine, midazolam, procedural sedation.

ABBREVIATIONS. PSA, procedural sedation and analgesia; P/F, propofol/fentanyl; K/M, ketamine/midazolam; RT, recovery time; OSBD-r, Observational Score of Behavioral Distress-revised; PED, pediatric emergency department; ED, emergency department; ASA, American Society of Anesthesia; TST, total sedation time; IV, intravenous; VAS, Visual Analog Scale; NPO, nil per os.

Procedural sedation and analgesia (PSA) is an important component of pediatric emergency care. The ideal agent for PSA for a brief painful orthopedic procedure would be safe and easy to administer, provide adequate amnesia and muscle relaxation, and have a rapid onset and offset.

Currently, ketamine is a popular choice for PSA.1–5 It has intrinsic analgesic and amnestic properties, protects airway reflexes, and can be administered by multiple routes of administration. However, it has the potential for undesirable side effects that include unpleasant emergence hallucinations and emesis.1,2,5–11 Ketamine is also relatively contraindicated in patients with hypertension, increased intracranial pressure, respiratory tract infection, or underlying neuropsychiatric comorbidities such as seizures or psychoses.7

Propofol is an intravenous (IV) sedative-hypnotic agent with amnestic properties that causes loss of consciousness reliably and rapidly. It is structurally unrelated to other hypnotics such as barbiturates and benzodiazepines and represents a new class of sedative hypnotics called disopropylphenols. It has been shown to have synergistic hypnotic effects when used in conjunction with other classes of analgesic/sedative agents as barbiturates, benzodiazepines, opioids, and ketamine.12–14 Because it is a poor analgesic, propofol usually requires the use of an adjunctive analgesic agent. Propofol is uniquely titratable and unlike ketamine, it has intrinsic antiemetic properties.15 It provides for a smooth recovery without dysphoria. Its adverse effects include respiratory depression, airway obstruction, and pain at the site of injection. Multiple studies in the adult population have compared propofol to midazolam.16,17 Propofol’s use is increasing in pediatric emergency departments (PEDs) across the country. Numerous uncontrolled studies, in the intensive care unit and operating room setting, have documented the efficacy of propofol for sedation in children.13,18–22 We are not aware of any previous studies performed in the PED setting that have compared the use of propofol to ketamine for sedation during procedures. Prior data comparing these 2 agents has
been from trials performed in the pediatric critical care unit.\textsuperscript{23,24}

In a recent randomized double blind prospective trial in children, propofol was noted to induce sedation as effectively as midazolam. Propofol had a shorter time of onset and recovery, with an equivalent safety profile.\textsuperscript{22} Similar results were noted when propofol was compared with the barbiturates in children undergoing sedation for magnetic resonance imaging.\textsuperscript{25}

We elected to examine the combination of propofol and fentanyl to ketamine and midazolam for the purpose of PSA for brief orthopedic manipulation in the PED with attention to the outcomes of recovery time (RT) and procedure-related distress.

**METHODS**

**Objective**

Our primary null hypothesis was that there was no difference in RT between IV propofol/fentanyl (P/F) and IV ketamine/midazolam (K/M). Our secondary null hypothesis was that there was no difference in procedural distress, as measured by the previously validated pain scale, known as the Observational Scale for Behavioral Distress-revised (OSBD-r).\textsuperscript{26,27} We also chose to examine the rate of adverse events and effectiveness of PSA using satisfaction scores as perceived by the orthopedic surgeon, sedation nurse, and parents. Lastly, patient recall of the procedure was also documented.

**Design**

This was a prospective, partially-blinded, controlled comparative trial conducted in the emergency department (ED) of LeBonheur Children’s Medical Center, which is a regional referral tertiary care center and the designated Comprehensive Regional Pediatric Center for West Tennessee with an annual ED census of 65 000 patients. This study was approved by the Institutional Review Boards at LeBonheur Children’s Medical Center and the University of Tennessee.

We included children aged 3 years to 18 years that required PSA for emergency orthopedic procedures. Exclusion criteria were American Society of Anesthesia (ASA) class III or greater, fractures \( \geq 24 \) hours old, and known allergy to any of the study medications or eggs. According to our institutional policy, all patients were fasting for at least 4 hours before the procedure. A convenience sample of eligible patients was recruited by 1 of 2 investigators (J.P. and S.A.G.).

Based on the results of previously published studies, we assumed that the mean RT with propofol would be 14.9 ± 11.1 minutes\textsuperscript{22} and that the mean OSBD-r score would be 1.08 ± 1.12 for PED procedures with ketamine and midazolam.\textsuperscript{9} To detect a difference in mean OSBD-r score of 1.05 and a 10-minute difference in RT, 50 subjects (25 in each group) were needed for an \( \alpha \) of 0.05 and power of 90%. We recruited patients for 10 months (September 2000 to June 2001) to capture the variety of seasonal sports injuries.

**Protocol**

Patients were enrolled in the study after caregiver consent and patient assent, when deemed appropriate, were obtained. A total of 140 patients were approached for participation, and 113 consented to participate in the study (Fig 1). Patients were assigned to P/F on odd days and K/M on even enrollment days. An odd or even day was defined as starting at 7 AM and ending at 7 AM on the following day. Children received narcotic analgesia at the treating physician’s discretion. The subjects and their parents were unaware of the patient-to-drug assignment protocol. In case of multiple attempts at reduction, only the initial attempt was included in the study. The design was based on intent-to-treat analysis.

The hospital policy was based on published ASA\textsuperscript{28,29} and American Academy of Pediatrics\textsuperscript{30} guidelines for PSA in pediatrics. Standard documentation and procedure, as required by the hospital sedation policy, was followed. The sedation nurse, who is solely responsible for documentation, used a stopwatch to independently record start times, RT, and time to discharge. This individual additionally noted any adverse effects occurring at any time after administration of medications until the time of discharge. Transient desaturation was defined as any amount of time during which a patient’s oxygen saturation was <90%. Supplemental oxygen was given to any patient with an oxygen saturation <90% that did not respond to any airway repositioning or suction. The RT was defined as the time that elapsed from when the last dose of medication was given to when the patient returned to his or her baseline. The total sedation time (TST) was defined as time that elapsed from when the first dose of medication was given to when the patient returned to baseline (Fig 2). The orthopedic reduction was performed by a senior orthopedic surgery resident with occasional assistance from their attending staff.
Medications

In the P/F group, IV fentanyl (1–2 μg/kg) was given slowly over 1 to 2 minutes and titrated to provide adequate analgesia. After 5 minutes, an initial bolus of 1 mg/kg IV propofol was followed by subsequent administration of smaller aliquots based on patient response. In the K/M group, IV midazolam (0.05 mg/kg to a maximum of 2 mg) was given slowly over 1 to 2 minutes. After 3 minutes, this was followed by IV ketamine (1 to 2 mg/kg) given slowly over 1 to 2 minutes. Given its unique properties, aliquots of propofol were administered in a seamless uninterrupted manner. Ketamine was also administered slowly. However, the rate of administration of propofol was slower than ketamine because of the greater potential for respiratory depression with rapid delivery of propofol. The dose of propofol was titrated to achieve adequate muscle relaxation and a relatively motionless state during the reduction. Ketamine was titrated to achieve adequate conditions for fracture manipulation by the orthopedic consultant. Our intent during PSA in the study subjects was to anticipate “deep” sedation, as defined by the ASA. A portion of the patient’s chest was exposed to allow appropriate monitoring of respiratory effort. None of the patients were preoxygenated.

Quantification of Distress and Satisfaction

The procedure was videotaped for independent review of outcomes. One or both investigators were present for all sedations. Ketamine is known to produce a characteristic dissociative state with nystagmus and a vacant gaze. To mask these “tell tale” facies from the reviewer, patients wore dark goggles (sunglasses) for the duration of the video recording. The patients, their parents, and the reviewers of the tapes were blinded to the type of medication administered. All medications and tubing were covered from view of the video camera and the parents (or legal guardians). Both investigators reviewed all the tapes continuously to ensure that the protocol was followed. In anticipation of a greater frequency of airway repositioning maneuvers during propofol use, random mock jaw thrusts were performed to reduce bias on the part of the reviewers. Equal numbers of jaw thrusts, both actual and mock, were recorded for both medication groups.

The independent blinded reviewers assessed the tapes in random order for patient’s behavioral distress as measured by the previously validated pain scale known as the OSBD-r. This scale records the occurrence of 11 behaviors at distinct time points within a medical procedure. The scores range from a minimal distress score of 0 to a maximal distress score of 23.5. The behaviors are weighted according to the amount of anxiety or distress that they represent. Intensity ratings vary along a 1- to 4-point scale in which 4 indicates maximal anxiety or pain. The behaviors measured are cry, scream, physical restraint, verbal resistance, request for emotional support, muscular rigidity, verbal pain expression, flail, nervous behavior, and information seeking. The OSBD-r scores were measured at 15-second intervals for 3-minute periods during the presedation period (before the administration of sedative medications) and during orthopedic manipulation. Reviewers were encouraged to record the point when the patient had the most distress during the 2 periods and the highest OSBD-r scores were included in the tabulations. One of our reviewers was a child psychologist and the other a pediatric registered nurse.

We ensured that each reviewer had a complete understanding of the scale with assistance of a personal communication with Dr. Susan Jay, who originally devised and validated the scale in children. We then went through a trial of 5 patient tapes (not part of the study subject population) with the reviewers to ensure familiarity with the anticipated behaviors during the painful procedure as measured by the scale.

After completion of the procedure, the parents that chose to be in the room were asked to rate the degree of pain they perceived their child had experienced during the procedure, using the Visual Analog Scale (VAS). This scale, which ranges from 0 mm or no pain to 100 mm or maximal pain, has been previously validated. The orthopedic surgeon and the sedation nurse were asked to complete a 5-point Likert scale (with 1 representing the least and 5 the highest level of satisfaction with the PSA). On return to baseline status, patients were asked if they recalled the procedure.

Patients and their families were then contacted by telephone by either J.P. or S.A.G., the primary investigators, 1 to 3 weeks following their ED visit, to assess their level of satisfaction with the medication regimen that they had received using a standard questionnaire. The script was consistent and followed the questions prepared before initiating the study. Any adverse effects noted were recorded.

Statistical Analysis

Dichotomous variables like yes/no responses were analyzed using the chi-square test and Fisher exact test if needed. Using the Student t test and Wilcoxon rank-sum test, we assessed RT and TST data. Similarly, the parental VAS and satisfaction scores were analyzed using the Student t test and Mann-Whitney U test. Because the results of these tests were comparable, the Student t test was used for reporting all continuous variables. Interrater reliability for all reviewed tapes was assessed during orthopedic manipulation using the Spearman correlation coefficient and an intraclass correlation coefficient. SPSS (SPSS, Chicago, IL), Statview (SAS Institute, Cary, NC), and Prism (GraphPad, San Diego, CA) software were used in the analyses.

RESULTS

A total of 113 (age range from 3.1 years to 16.3 years; median age 9.0 years; mean age 9.2 years) were enrolled in the study during the 10-month study period. As shown in Table 1, the patients in each group did not differ in age, sex, race, weight, nil per os (NPO) time, use of opioid premedication, and type of injury. The incidence of fully successful, partially successful, and unsuccessful reductions was equivalent between our 2 treatment groups as shown in Table 1.

No patient was entered into the study twice. All procedures were videotaped except for 3 patients because of unavailability of the recording equipment. These 3 patients (1 from the K/M group and 2 from the P/F group) were included in all analyses except for the OSBD-r assessment. One additional subject from the K/M group was excluded from the RT/TST analysis but included for the qualitative satisfaction analyses including the OSBD-r. This patient
underwent a prolonged sedation during which multiple procedures (knee arthrocentesis, suturing of lower leg laceration, and pin placement for femur fracture reduction) were done. The mean medication doses used in each group are shown in Table 2.

The results of the RT and the TSTs are shown in Fig 3. The RT and TST for P/F were shorter by 33.4 minutes and 23.2 minutes, respectively ($P < .0001$). The mean set up time (calculated by subtracting the mean RT from the mean TST) for K/M was 7.8 minutes and for P/F was 18.1 minutes (Fig 2). The set up times for the 2 drug regimens are different because in general, the rate of administration of propofol was slower than ketamine.

The immediate complications are described in Table 3. Transient desaturation occurred in 18 of 59 (31%) patients in the P/F group and in 4 of 54 patients (7%) in the K/M group. No patient in either group had apnea. Pain on injection of medication was observed in 2 of 59 patients in the P/F group only. Emergence agitation and emesis were seen in 5 of 54 patients in the K/M group. A single episode of hypotension occurred in an 11-year-old, 43.7-kg boy that received P/F during the manipulation of a closed right distal radial and ulnar fractures. The lowest blood pressure recorded was 74/49. The blood pressure was rechecked in 15 seconds and was 104/59. The episode was not accompanied by changes in perfusion, pulse quality, or heart rate. The single episode of laryngospasm in the P/F group was seen in a 5-year-old, 20-kg male with closed right distal radial and ulnar fractures was transient and self-resolved. During administration of propofol, this patient had a <30-second period of stridor with cough and desaturation to 88%. This resolved with airway repositioning, suction, and supplemen-

tal oxygen. Careful examination of the desaturation events and the interventions needed to overcome these events is shown in Table 4. In the P/F group, many episodes were corrected with a jaw thrust maneuver or airway repositioning, but 15 of 59 (25%) patients required supplemental oxygen. Five percent (3/54) of patients in the K/M group required supplemental oxygen. No patient required assisted ventilation or fluid resuscitation.

At phone follow-up 1 to 3 weeks after the initial ED visit, delayed adverse effects were noted exclusively in the K/M group and occurred in 5 of 50 (10%). By parental report, all cases of delayed reactions occurred within the first 72 hours. Dysphoric reactions were observed in 3 patients and nausea or emesis was seen in 2 patients. Table 5 displays the details of the patients who had delayed adverse re-

<table>
<thead>
<tr>
<th>TABLE 1. Patient Characteristics</th>
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<tbody>
<tr>
<td>K/M (N = 54)</td>
</tr>
<tr>
<td>Age, y (±SD)</td>
</tr>
<tr>
<td>Male/female</td>
</tr>
<tr>
<td>Race</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Hispanic</td>
</tr>
<tr>
<td>Mean weight, kg (±SD)</td>
</tr>
<tr>
<td>Opioid premedication</td>
</tr>
<tr>
<td>NPO time, min (±SD)</td>
</tr>
<tr>
<td>Type of injury</td>
</tr>
<tr>
<td>Upper</td>
</tr>
<tr>
<td>Lower</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Successful reduction</td>
</tr>
<tr>
<td>Partially successful</td>
</tr>
<tr>
<td>Unsuccessful reduction</td>
</tr>
</tbody>
</table>

SD indicates standard deviation.

<table>
<thead>
<tr>
<th>TABLE 2. Medication Doses Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Dose</td>
</tr>
<tr>
<td>Ketamine</td>
</tr>
<tr>
<td>Midazolam</td>
</tr>
<tr>
<td>Propofol</td>
</tr>
<tr>
<td>Fentanyl</td>
</tr>
</tbody>
</table>

Fig 3. RT and TST. Box whisker plots of the results of the RT (A) and TST (B) for each of the medication groups are shown. They display the means, first and third quartiles, and ranges. The mean values are listed at the top of each plot. The numbers adjacent to each plot show the actual values of the maximum, median, and minimum data points. C. The mean differences in the RT and TST between K/M and P/F. The differences between the RT and TST are statistically significant for each age group ($P < .0001$).
actions. The second patient listed, who was 7.1-year-old, had a femur fracture after a car had struck him. He had nightmares of being “about to be hit by a truck.” These nightmares may have been related to the mechanism of injury rather than to the K/M regimen itself.

As shown in Table 6, there was no statistically significant difference between groups with regards to the orthopedic and sedation nurse satisfaction scores. In each instance, the Likert scores were >4.8 and suggested satisfactory sedations for both medication regimens. Parents were encouraged to stay in the room during the procedure. Thirty of 54 parents in the K/M group (56%) and 38 of 59 parents in the P/F group (64%) elected to remain in the room with their injured child during the procedure. Parental visual analog scores were not statistically significant between the 2 groups. The mean VAS scores of 13.0 and 8.7 for K/M and P/F, respectively, indicated the parents felt that their children suffered minimal pain during the procedures. None of the subjects had any recall of the procedure. At phone follow-up, 1 to 3 weeks after the ED visit, the parents of all patients but one expressed a preference for the same medication regimen they preferred most, 3 of the surveys indicated K/M and the other 3 indicated P/F. P/F was preferred during difficult reductions that required greater muscle relaxation. Because the turnaround time with P/F was shorter, the latter was also preferred when they had multiple patients in the department that required PSA. In accordance with our departmental policy, only 1 PSA can be performed at any given time. In settings where multiple patients can be sedated at any given time in the ED, this may not be the case. Those orthopedic surgeons that preferred K/M pointed out its ease of use related to the mechanism of injury rather than to the K/M regimen itself.

TABLE 3. Occurrence of Immediate Adverse Effects

<table>
<thead>
<tr>
<th>Type</th>
<th>K/M (54)</th>
<th>P/F (59)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desaturation</td>
<td>4</td>
<td>18</td>
<td>.002</td>
</tr>
<tr>
<td>Agitation</td>
<td>3</td>
<td>0</td>
<td>.106</td>
</tr>
<tr>
<td>Emesis</td>
<td>2</td>
<td>0</td>
<td>.226</td>
</tr>
<tr>
<td>Pain</td>
<td>0</td>
<td>2</td>
<td>.497</td>
</tr>
<tr>
<td>Hypotension</td>
<td>0</td>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td>Laryngospasm</td>
<td>0</td>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td>Apnea</td>
<td>0</td>
<td>0</td>
<td>1.000</td>
</tr>
</tbody>
</table>

TABLE 4. Subgroup Analysis of Interventions for Respiratory Complications

<table>
<thead>
<tr>
<th>Type</th>
<th>K/M (4)</th>
<th>P/F (18)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jaw thrust</td>
<td>1</td>
<td>15</td>
<td>.003</td>
</tr>
<tr>
<td>Supplemental oxygen</td>
<td>3</td>
<td>10</td>
<td>.078</td>
</tr>
<tr>
<td>Reposition</td>
<td>2</td>
<td>2</td>
<td>1.000</td>
</tr>
<tr>
<td>Suction</td>
<td>1</td>
<td>0</td>
<td>.478</td>
</tr>
<tr>
<td>Positive pressure ventilation</td>
<td>0</td>
<td>0</td>
<td>1.000</td>
</tr>
</tbody>
</table>

DISCUSSION

Our study demonstrates that the RT with the combination of propofol and fentanyl is shorter than with ketamine and midazolam. We also demonstrated that P/F is comparable to K/M in reducing the procedural distress associated with painful orthopedic procedures in the PED.

Although the mean OSBD-r scores were greater in the P/F group, both groups of medications were successful in keeping the distress scores low during the procedures. The difference between the K/M and P/F groups OSBD-r scores, although statistically significant, are clinically insignificant. In each instance, the mean score was <1, indicating very minimal distress. The mean scores in both groups were lower than previously reported in the literature.5,35 Wathen et al35 reported mean OSBD-r scores of slightly <1 during the procedure with 1 mg/kg of ketamine. Kennedy et al5 administered a mean dose of 1.76 mg/kg of ketamine in their study subjects. The mean OSBD-r scores were 1.08. We speculate that the slightly lower scores in our subjects who received K/M may be attributable to a greater mean dose of ketamine (1.99 ± 0.58 mg/kg). However, K/M produced consistently effective conditions, whereas P/F had at least some unsatisfactory and/or borderline sedation conditions.

There are currently no published studies comparing propofol and ketamine during procedural sedation. Havel et al22 prospectively compared propofol and midazolam during orthopedic procedural sedation. They concluded that propofol was comparable to midazolam in efficacy and had a shorter RT. Our study results were similar and reflect the unique pharmacokinetic profile of propofol. Moreover, time from initial administration to manipulation was greater in the P/F group when compared with K/M.

At the completion of our study, an open-ended, formal survey was conducted. The 10 orthopedic surgeons that had participated in the study were mailed a brief questionnaire. Six completed questionnaires were returned. When asked which medication regimen they preferred most, 3 of the surveys indicated K/M and the other 3 indicated P/F. P/F was preferred during difficult reductions that required greater muscle relaxation. Because the turnaround time with P/F was shorter, the latter was also preferred when they had multiple patients in the department that required PSA. In accordance with our departmental policy, only 1 PSA can be performed at any given time. In settings where multiple patients can be sedated at any given time in the ED, this may not be the case. Those orthopedic surgeons that preferred K/M pointed out its ease of use related to the decreased time to onset of optimum conditions for fracture manipulation.

Our study had several limitations. The decision to use a convenience sample was based on the availability of the 2 principal investigators. Patient recruitment was also in the context of a busy ED. High census or acuity in the department did not permit subject recruitment. We recognize that this was a limitation of the study. However, we believe it
Propofol can cause respiratory depression with loss of airway tone, necessitating airway interventions. No patient in our study had apnea or required the use of assisted ventilation. The routine use of an anti-sialogogue could have reduced our incidence of adverse respiratory events.

Another potential limitation was that we did not objectively measure the depth of sedation. Our study experience suggests that to achieve a relatively motionless state during painful orthopedic procedures requires deep sedation. None of the study patients experienced an aspiration event, nor did they require assisted ventilation. We believe that our presedation screening for potential airway problems, vigilant monitoring for early signs of airway obstruction, and strict adherence to the hospital sedation policy, based on the guidelines outlined by the American Academy of Pediatrics and ASA Committees on Sedation, was responsible for the relative lack of significant adverse events or escalation of care. This appears to be consistent with the experience at other similar institutions. Strict adherence to a generalized risk assessment tool reduced the rate of adverse events even with deep sedation at the Children’s Hospital of Wisconsin. We did not include end-tidal carbon dioxide monitoring during our sedations. Its use may add to the safety of procedural sedation by detecting hypoventilation earlier than with clinical assessment and pulse oximetry.

The rates of dysphoric reactions and emesis with the use of K/M are consistent with the incidence reported in other studies. It could be argued that the addition of midazolam may have prolonged the RTs with ketamine. At the time of this study, we felt that adjunctive midazolam would mitigate the ketamine-induced dysphoria experienced especially by older children and teenagers. Since then, 2 large studies have examined the role of midazolam in conjunction with ketamine. The results are not conclusive. Emesis is an important adverse event that can occur during or after procedural sedation. The incidence of emesis in conjunction with PSA needs to be examined further. Macario et al described that in postoperative adult patients, avoiding nausea and

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Effect</th>
<th>Description</th>
<th>RT (Minutes)</th>
<th>TST (Minutes)</th>
<th>K Dose</th>
<th>M Dose</th>
<th>Premedication (Type)</th>
<th>Location of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.9</td>
<td>Nightmare</td>
<td>“Someone is in my closet”</td>
<td>84</td>
<td>95</td>
<td>2.65</td>
<td>0.04</td>
<td>Yes (morphine)</td>
<td>Tibia</td>
</tr>
<tr>
<td>7.1</td>
<td>Nightmare</td>
<td>“About to be hit by a truck”</td>
<td>70</td>
<td>75</td>
<td>1.92</td>
<td>0.07</td>
<td>Yes (morphine)</td>
<td>Tibia</td>
</tr>
<tr>
<td>8.5</td>
<td>Nausea</td>
<td>Lasted for several days</td>
<td>41</td>
<td>53</td>
<td>2.41</td>
<td>0.05</td>
<td>Yes (morphine)</td>
<td>Tibia</td>
</tr>
<tr>
<td>6.3</td>
<td>Behavioral change</td>
<td>“Talking to his imaginary brother”</td>
<td>46</td>
<td>50</td>
<td>2.11</td>
<td>0.02</td>
<td>Yes (morphine)</td>
<td>Tibia/fibula</td>
</tr>
<tr>
<td>9.2</td>
<td>Emesis and nightmare</td>
<td>Emesis 6 h “demons were going to get her”</td>
<td>59</td>
<td>63</td>
<td>1.55</td>
<td>0.06</td>
<td>None</td>
<td>Radius/ulna</td>
</tr>
</tbody>
</table>

The results of the Orthopedic and Nursing Satisfaction Scales are reported on a scale of 1 to 5 with 1 representing a poor sedation score and 5 representing the maximal satisfaction with a given sedation. Parental Visual Analog Scores are reported on a scale of 0 to 100 mm with 0 representing no perceived patient pain and 100 representing the maximal amount of perceived patient pain.
vomiting was a high priority. In Sherwin et al.,8 the incidence of emesis was 2% in the K/M group and 12% in the ketamine/placebo group. In Watthen et al.25 a decreased incidence of emesis was observed when midazolam was given in conjunction with ketamine, 19.4% versus 9.6%, respectively. Moreover, the mean age of the ketamine only group was <7 years.8,25 Additionally, as suggested by Kennedy and MacAllister,40 there is limited data about the medium to long-term sequelae of ketamine sedation.

Because the caller during our telephone surveys after the sedation was not blinded to the medication administered, the validity of the results concerning the increased incidence of nightmares seen with K/M are in question.

It can be argued that the injured patient has delayed gastric emptying time and the conventional preoperative NPO guidelines are inadequate to reduce aspiration risk. Based on recent reviews of ED sedations, the risk of clinically significant aspiration syndrome is negligible. Failure to adhere to the NPO guidelines may not increase this risk because of its intrinsic anti-emetic properties.15 Nonetheless, our NPO times were in accordance with our hospital policy. The latter was consistent with the above-mentioned ASA fasting guidelines for sedation. As indicated in Table 1, the mean NPO time was over 8 hours for both groups. None of the study subjects experienced a clinically significant aspiration event.

CONCLUSIONS

We believe that propofol offers some unique advantages for brief procedural sedation in the ED. It is short-acting, and has a rapid offset resulting in shorter postsedation monitoring and a smoother recovery profile. It does have a greater potential for respiratory depression as compared with ketamine. Hence, greater vigilance and experience with the pediatric airway is suggested with its use.

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Fig 4. OSBD-r. The top graph shows a graphical representation (as a box-whisker plot) of the OSBD-r scores from the 2 intervals examined, namely the presedation period and during the actual orthopedic reduction. For each group, the median and 25th percentile value is 0. The chart below summarizes the statistical analysis. The P value for the difference in the presedation OSBD-r scores is .787, and for the reduction OSBD-r scores is .008.


**MOTHERING AND APOPTOSIS**

“... If an infant mouse is deprived of its mother’s attention for a single day, its brain cells commit suicide at twice the rate of the cells of its steadily mothered counterparts.”

*Ackerman J. Chance in the House of Fate*. Boston, MA: Houghton Mifflin; 2001

Submitted by Student