

## Preliminary report on the use of ketamine in pediatric dentistry

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### Abstract

*Preliminary results indicate that ketamine 3mg/kg combined with diazepam and atropine may be an excellent premedication/sedation for children who require dental treatment procedures 45-60 minutes in duration. Ketamine HCl, 4 mg/kg appears to be effective for procedures lasting less than 30 minutes. Because of transient apnea, noted in two references,<sup>2,3</sup> only dentists trained in airway management should use this drug at the present time. Local, state, and federal regulatory agencies must standardize the definition of conscious sedation, deep sedation, and general anesthesia in order to provide guidelines to practicing dentists, insurance companies, and courts. Further experience is necessary before the procedure can be recommended for office use.*

**P**edodontists have taken different philosophical and practical approaches toward premedication and/or sedation of children for dental care. The use of premedication is as much an art as a science, and has been integrated judiciously with proper psychological approaches to allow treatment of young and problem children on an outpatient basis. Most commonly, the drugs utilized are hypnotics, antianxiety agents, narcotics, or combinations of these drugs.

A large number of preoperative and handicapped children are treated in the postdoctoral pediatric dental clinic at UCLA. Most of these children tolerate or enjoy their experience without the aid of premedication. For the minority, however, who cannot tolerate these procedures, the Section of Pediatric Dentistry has used, and continues to use, a variety of sedating agents, routes of administration, and philosophies toward these drugs. One of the most effective drugs for deep sedation was alphaprodine.

When alphaprodine was withdrawn from the market in the fall of 1980, it left a gap in the deep sedation protocol at UCLA. In the search for an alternate method of medication, an attempt was made to find a drug or drug combination with as many of the following characteristics as possible:

1. no respiratory depression at clinically workable doses
2. no cardiovascular effects
3. rapid onset of action with a clinically acceptable duration of action
4. rapid recovery with minimal discomfort
5. amnesia, analgesia, coupled with deep sedation\*
6. an administration route which was either oral, IM or SQ, or a combination of the two.

It was decided to try several drugs and combinations of drugs before relying on any one method. One of the drugs selected for trials was ketamine HCl. This paper will report on the preliminary trials of that drug.

### Literature Review

Ketamine is a chemical derivative of phencyclidine (PCP) with the formula 2-(o-chlorophenyl)-methylamino cyclohexanone HCl. The drug was first derived in 1961<sup>1</sup> and human trials were begun in 1965.<sup>2,3</sup> The action of the drug is similar to PCP but the duration is shorter. The analgesic and amnesic properties remain, but the excitatory and hallucinogenic effects are reduced considerably both in incidence and duration. The psychomimetic effects of the drug do not appear to be a serious problem in children,<sup>4,5</sup> as has been reported in adults,<sup>2,3,6</sup> especially when used in low, "subanesthetic" doses and/or when given intramuscularly. The drug does not appear to have a lasting effect on respiration, although a transient, minimal decrease can be noted in some cases and several isolated instances of transient apnea have been reported with low dosages.<sup>2,3</sup> Cardiovascular effects

\* In the Pediatric Dental Clinic at UCLA, deep sedation is defined as the use of drugs to induce tranquility, an absence of fear and apprehension, and some degree of cortical depression so that the patient can sleep or be disassociated during treatment. The patient also will be able to respond to stimuli such as sharp commands, pressure, and pain and maintain protective laryngeal reflexes to protect his airway. Deepening the sedation tends to reduce the avoidance response during noxious stimulation and finally will culminate in general anesthesia where all sensations are eliminated, the patient is unconscious, and stimulation will not cause arousal or avoidance reactions.

are primarily hypertensive, demonstrating approximately a 20–25% increase in BP and pulse rate which lasts somewhat longer than the anesthetic effect.<sup>2,3</sup> The eyelash reflex, as well as the pharyngeal and laryngeal reflexes appear to remain intact,<sup>2,3</sup> although several reports have indicated minor airway contamination when studied with radiopaque dyes.<sup>7</sup> Laryngospasm has been reported in only 0.4% of cases,<sup>8</sup> and has been managed with 100% positive pressure oxygen.<sup>8,9</sup>

Vomiting appears to be a problem in 3–5% of cases<sup>4,10–12</sup> and appears to be dose-related. Atropine tends to lessen the emesis by reducing the increase in salivary flow caused by ketamine.<sup>12</sup>

When ketamine is administered intravenously in doses of 1–2 mg/kg, the onset of anesthetic coma occurs within 30 to 60 seconds, and lasts approximately 5–10 minutes.<sup>2,3</sup> If given intramuscularly, the potency is approximately 1/5 to 1/6 that of the intravenous dose,<sup>4</sup> however, the duration is 12–25 minutes depending upon the dose, which may range from 6 to 15 mg/kg.<sup>2,3,10</sup>

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The chlordiazepoxides, such as valium, appear to have several effects on the action of ketamine. The duration of the anesthesia or analgesia is increased as has been demonstrated by Lo and Cummings in 1975.<sup>13</sup> Borondy demonstrated that this was due to a competitive inhibition of the N-dealkylation of ketamine.<sup>14</sup> Diazepam also appears to decrease the number and severity of psychic emergence disturbances which may occur with the use of ketamine alone.<sup>15–18</sup> Currently, no agent is available to reverse the effects of ketamine overdose.

Contraindications for use of ketamine include:

1. high blood pressure (clinical hypertension)<sup>4</sup>
2. increased intracranial pressure<sup>19</sup>
3. children under one year of age<sup>4</sup>
4. patients with psychiatric disorders<sup>16</sup>
5. patients with upper respiratory and/or nasal congestion.<sup>20</sup>

Although the drug primarily has been used as an anesthetic agent in the operating room, a considerable number of reports have demonstrated its usefulness in burn wards,<sup>21</sup> as a premedication during radiotherapy,<sup>22,33</sup> as an analgesic and/or anesthetic in pediatric wards for painful procedures,<sup>4</sup> and as an analgesic pre-

medication/sedation for outpatient procedures including dentistry.<sup>10–12,24,25</sup> It would appear that ketamine, alone or in combination, in low, subanesthetic doses may be a useful sedation medication in pediatric dentistry. This study is an attempt to determine the drug combinations and dosages which will best fulfill our criteria of deep sedation without general anesthesia in young pediatric dental patients.

## Methods and Materials

The patient population was drawn from children requiring restorative dentistry who could not be managed by behavioral techniques or by sedation with nitrous oxide/oxygen, 5–10 mg valium, or other anxiolytic agents alone. The ages ranged between 18 months and 5 years with equal sex distribution and no previous dental experience or previous sedation with promethazine and alphaprodine. These were patients who would have been premedicated with promethazine and alphaprodine had it been available. Each parent was asked to sign a release form after being informed of the risks of the premedication. The form was witnessed by the nurse and dentist involved.

The drugs and drug combinations evaluated included ketamine HCl 0.5–4 mg/kg, atropine 0.3 mg, nitrous oxide/oxygen, diazepam 5–10 mg, and promethazine 25–50 mg.

The procedure was to sedate the first child with the most simple dosage schedule at the lowest dose recommended in the literature, and increase the dosage for each succeeding child until an adequate sedation level was achieved or our dosage limit was reached, whichever occurred first. Adequate sedation was defined operationally as the absence of head and body movements which, combined with passive restraints, would allow restorative dental procedures. The dosage limit for ketamine arbitrarily was established at 4 mg/kg, which is two-thirds the minimum anesthetic dose.<sup>4</sup>

The child's BP, pulse, and respiration rate were taken before the ketamine was administered, and at 15-minute intervals during the procedure until the child had recovered to the point of parent recognition and response.

## Results

In general, dosages of less than 2.5 mg/kg ketamine, even when combined with nitrous oxide/oxygen, chloral hydrate, promethazine, or valium have had marginal or inadequate effect, and a duration of less than 30 minutes. Five of our initial patients were given the above dosages and although they appeared disoriented they were not quiet or sufficiently sedated for routine dental procedures.

Dosages of 3 mg/kg combined with 5–10 mg diazepam resulted in an onset of sedation in 5–10 minutes with a duration of 45–60 minutes. Onset was evident by the eyes opening if they were closed, quivering of the eye-

balls, and a disassociated fixed stare. In some cases, vocalization or crying occurred without stimulation but were not accompanied by avoidance movements. In one case, vomiting occurred 40 minutes after administration from inadvertent soft palate stimulation during crown cementation. No aspiration occurred and the procedure was completed using 25% nitrous oxide/oxygen. In this case only 35 minutes had elapsed between the diazepam PO and the ketamine injection. Five cases were treated using this regimen. Recovery occurred from 75 to 120 minutes after the ketamine injection.

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during local anesthetic injections, however, reactions to heavy pressure and/or movement, even in areas of local anesthesia, were noted throughout the procedures. All 10 cases treated using this regimen were considered to be satisfactory, although recovery was prolonged slightly (up to 160 minutes after injection) due to the promethazine.

Dosages of 4-4.5 mg/kg combined with atropine appear to work well for short periods, giving a more rapid onset, (1-5 minutes) and a deeper disassociation. These dosages, however, are approaching the range of general anesthesia, and in California may be contravening Article 2.7 of the Dental Practice Act (Sections 1646-1646.9 of the Business and Professions Code). Even deeper

sedation or general anesthesia may occur at these doses if nitrous oxide/oxygen is administered concurrently. Of the five patients treated with this regimen, all were judged to be satisfactory for 15-35 minutes (Table 1).

Generally, BP and pulse rate increased only 10-15%, for a duration of 15-45 minutes at the most and were not felt to be significant. Respiration did not vary significantly in rate or visually observable volume.

## Discussion

At present, it appears that ketamine, combined with diazepam, and perhaps other medication, such as promethazine and atropine, may hold promise as a premedicant in young children. At IM dosages of 3 mg/kg, coupled with diazepam and atropine given orally or by injection, the sedation was excellent. Occasionally, movement and crying occurred. However, this also occurred with alphaprodine sedation. The duration of the sedation should be adequate for most cases in a private practice setting. There is the possibility of extending the sedation duration by judicious use of nitrous oxide/oxygen toward the end of the procedure if it extends longer than 45-60 minutes also. Recovery appears to occur within 75 to 120 minutes after the ketamine injection if diazepam is used, so the child can be discharged to his parents in a reasonable time.

Administering a lower than recommended dose of a drug such as ketamine may be safer than the heavy doses of narcotic necessary to achieve adequate levels of sedation in some children, with their attending problem of potentially severe respiratory depression. At present, however, we cannot reverse the effects of ketamine as is possible with narcotics.

It is too soon to determine if the medications discussed will become a useful part of pedodontists' regimen in private practice. Although several combinations appear promising, more experience will have to be gained before these procedures can be recommended outside the dental school or hospital environment.

	Ketamine Dosage mg/kg	Comedication Utilized	Number of Patients	Quality of Sedation	Duration (Minutes)	Recovery (Minutes)	Side Effects
<b>Table 1.</b> Results of Various Dosages of Ketamine HCl	≥2.5	Diazepam Atropine N <sub>2</sub> O	5	Unsatisfactory	<30	45	None*, **
	3.0	Diazepam Atropine N <sub>2</sub> O	5	Satisfactory	45-60	120	1 Episode of Vomiting*
	3.0	Diazepam Phenergan Atropine N <sub>2</sub> O	10	Satisfactory	45-60	160	None*
	4.0-4.5	Atropine N <sub>2</sub> O	5	Satisfactory	15-35	120	None*

\* Pulse rate and blood pressure increased 15-20% in all cases. \*\* Nonstimulated vocalizations during attempted sedation.

At this point in this investigation, several questions remain to be answered.

1. What are the legal ramifications of the use of this drug? (It is now classified as a general anesthetic.)
2. Will the addition of promethazine to the regimen decrease the propensity toward vomiting?
3. Although few psychological effects have been observed, how will these effects influence future dental care for the child?

We plan to do an extensive study of ketamine in subanesthetic doses to further refine the technique and ensure its safety. Various monitoring techniques will be used to collect heart and respiration rate data on a continual basis, along with periodic BP recordings for all future cases studied. Postoperative questionnaires will be given to all parents or guardians to determine the psychological state of the child following the procedure.

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## Correction

The list of references for the article, *Oral electrical burns in children — early treatment and appliance fabrication*, by Drs. E. Joseph LeCompte and Barry M. Goldman, appearing on page 337 of the December issue was incomplete. References 8 - 16 for this article appear at the end of the next article on page 340.