Oral midazolam with and without meperidine for management of the difficult young pediatric dental patient: a retrospective study

John E. Nathan, DDS, MDS Kaaren G. Vargas, DDS, PhD

Dr. Nathan is associate professor, Department of Surgery, Northwestern University Medical School; Dr. Nathan is adjunct professor, and Dr. Vargas is assistant professor, Department of Pediatric Dentistry, University of Iowa College of Dentistry, Iowa City, Iowa. Correspond with Dr. Nathan at drjnathan@aol.com

Abstract

Purpose: The purpose of this retrospective study was to examine different dosages of midazolam used alone or in combination with different dosages of meperidine for managing difficult young pediatric dental patients.

Methods: Patient records and sedation logs of 120 moderately to severely apprehensive/uncooperative subjects, ages 24-48 mos, sedated in private practice setting, were reviewed. Subjects, divided into six groups of 20, received midazolam in doses of 0.7 or 1.0 mg/kg with and without meperidine in doses of 1.0 or 1.5 mg/kg. Ratings of the effectiveness of sedation, duration of action, need for restraint to accomplish treatment, and recovery times were made. Nitrous oxide was not used.

Results: When used alone, use of 0.7 mg/kg midazolam produced the most agitation, required restraint most frequently, and produced the shortest working time ($P<0.001$). Subjects receiving 1.0 mg/kg midazolam and meperidine were the most effective, completing 20/20 visits with no need for restraint, no loss of consciousness throughout appointments, and no adverse reactions ($P<0.001$). Use of lower dose midazolam and higher dose meperidine was reliable, permitting treatment to be completed without restraint in 18/20 patients. Combined higher doses of both agents demonstrated somnolence and oversedation. The addition of meperidine increased working time ($P<0.05$).

Conclusions: The addition of meperidine appears to enhance the effectiveness and duration of action of midazolam for managing difficult young pediatric patients.*(Pediatr Dent 24:129-138, 2002)*

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Selected for its potential to obtund difficult and resistive behaviors in young pediatric dental patients, rapid onset, and amnesic qualities, use of oral midazolam has become widespread. Although its effectiveness has been shown,[1-14] the usefulness of midazolam alone is generally limited to short duration (less than 10-15 minute) procedures. Need currently exists for controlled data to identify safe and effective oral conscious sedation regimens which permit longer duration procedures.

Meperidine has been used effectively and safely in combination with sedatives/hypnotics for many years yet no study has examined this agent in combination with midazolam for lengthier pediatric dental treatment visits.

The objective of this retrospective study was to examine different doses of midazolam used alone and in combination with different doses of meperidine for managing difficult young and pre-cooperative patients. It was hypothesized that addition of meperidine would provide analgesic benefits to potentiate the sedative and calming effects of midazolam and enable longer working time without compromise of patient consciousness or interactiveness, normal physiologic function and recovery. It was expected that longer periods of conscious sedation (30-60 minutes) would permit more comprehensive in-office treatment, which might otherwise necessitate use of unconscious, higher risk, and more costly management strategies.

This study seeks to explore the potential of a midazolam-meperidine combination as an alternative to chloral hydrate regimens where hypnotic dosages frequently result in unpredictable and often protracted periods of intra- and post-operative somnolence. An additional safety consideration in selecting a midazolam-meperidine combination over chloral hydrate includes the availability of reversal agents for both benzodiazepine and narcotic.[15-16] Lastly, the capacity for amnesia of unpleasant procedures known to occur with midazolam can be expected to further enhance its usefulness for this particular population.[17,18]

Substantive data to support the ability to extend the efficacy and safety of midazolam by the addition of a co-medication such as meperidine, while maintaining consciousness and protective reflexes, will make this regimen a welcome addition to the pediatric dental sedation arsenal.

Background

Orally administered midazolam has been used as a pre-medicant to general anesthesia for almost 20 years.[19,20] Subsequent studies[21-27] began to examine the efficacy of midazolam in alleviating anxiety as an agent for conscious sedation in more stressful situations, such as those during laceration repairs, pain management in pediatric intensive care, endoscopy, and pediatric dental treatment.

Lampshire's[28] concept of "balanced medication" has long served as a theoretical basis for modern-day drug combinations. It should be recognized that most single agents, while providing beneficial effects for a given situation, are generally not without some undesirable side-effects. By adding secondary agent(s), additional beneficial drug qualities can accrue while offsetting any undesirable effects which arise from the primary agent. The addition of opioids or their derivatives to sedative agents for the purpose of enhancing sedation and providing analgesic benefits to overcome painful stimuli has become commonplace.[13,29-36] Studies, including the use of meperidine with midazolam and other frequently employed pediatric sedative agents, are reviewed below.

Reviews of medical and dental use[4,8,20,37-42] of midazolam have been provided in the literature. To date, only two medical trials have reported the effects of midazolam combined with meperidine. O'Mara et al[43] compared 2.0 mg/kg meperidine vs. 2.0 mg/kg meperidine with 0.05 mg/kg midazolam in a randomized double-blind trial of 40 patients (ages 1-17 yrs) undergoing endoscopy. Reporting no significant differences between drug conditions, success rates of 71% and 79%, respectively, were found; amnesia was noted in 23% of subjects receiving meperidine and in 78% of the subjects receiving the midazolam combination. Despite intravenous administration, neither regimen reportedly experienced adverse reactions, depression in vital signs, or oxygen saturation.

Marx et al[34] compared IV meperidine 2 mg/kg + 0.1 mg/kg midazolam vs. midazolam 0.05 mg/kg + ketamine 1.5 mg/kg in a randomized, double-blind crossover study for 22 pediatric patients (24-178 mos) undergoing painful oncology procedures. The ketamine group experienced significantly less distress ($P< 0.05$), more rapid recovery, and fewer side effects. All subjects experienced amnesia of the procedure seven days post-treatment.

Pediatric dental trials have studied the impact of adding oral meperidine to chloral hydrate for managing difficult young patients under the age of six years. In one retrospective study, comparisons were made between chloral hydrate dosages of 50 and 70 mg/kg, with and without 1.0 mg/kg meperidine. Across 135 sedation visits, Nathan and West[31] observed a 46% improvement in the success of sedations (defined by the ability to complete treatment without need for persistent application of physical restraint) when 1.0 mg/kg meperidine was used, regardless of the dosage of chloral hydrate. The addition of meperidine was found to enhance predictability and safety of sedations, reduce the need for the higher chloral hydrate dosage, and thereby reduce the incidence of somnolence during and after treatment.

Hasty et al,[32] in a well-designed and controlled prospective study, reported significant and similar improvement from the addition of meperidine to chloral hydrate with respect to a lesser incidence of interfering patient movement, crying behaviors, and somnolence.

A recent retrospective review[13] compared behavioral and physiologic response patterns of three groups of 100 subjects, 2-5 yrs of age, who received either chloral hydrate-hydroxyzine, chloral hydrate-hydroxyzine-meperidine, or midazolam. Specific dosaging criteria was not stated. Quiet behaviors occurred for 26%, 41%, and 67%, respectively; sleep was observed 50%, 43%, and 1%, respectively, for the three drug conditions. Midazolam subjects were reported to manifest the quietest behaviors prior to introduction of noxious stimulation, with a shift to crying and struggling behaviors. Its duration of action was notably short, 10-15 minutes. The meperidine group manifested the calmest and interactive behaviors during the latent and operative periods compared to the other groups. Unfortunately, dosages or dosage criteria for the three regimens were not reported and all subjects received 50% plus or minus 10% nitrous oxide. As a result, the ability to derive conclusions regarding the efficacy of the primary agent (s) or the impact of nitrous oxide was somewhat obfuscated. Nevertheless, the authors' observations and conclusions were consistent with earlier reports[31,32] and support the feasibility of effectively and safely adding meperidine to midazolam as hypothesized in this investigation.

Methods

Subject selection

Patient records and sedation logs of 120 moderately to severely apprehensive/uncooperative subjects, ages 24-48 mos, sedated in a private practice setting, were reviewed. Subject selection was based upon clinician- and parent-perceived need for physical restraint to permit delivery of restorative

and/or surgical care. Subjects were included who had either no previous dental experience or a history of negative treatment encounters. Age limitations[44] imposed were expected to minimize or eliminate possible inclusion of subjects with cooperative potential or non-anxious behaviors. Subjects who were either pre-cooperative or received Frankl[45] ratings of definitely negative behaviors were included. Each subject underwent only one visit.

All subjects had received pre-treatment ratings for anxiety and cooperation potential which served as the basis for agent and dosage selection. Subjects were judged to be in need of either preventive medication (using lower dosages to manage mild to moderate apprehension, where deterioration in cooperation was anticipated) or management medication (more potent dosages to manage heightened levels of apprehension/resistance). Anxiety was rated as mild, moderate, or severe. Ratings of the child's capacity to respond to verbal requests were also included. Given the age range included, children under three years of age were considered largely below the age of reason.

Experimental groups

Subjects, divided into six groups of 20, received one of the six following experimental conditions:

Group I: 0.7 mg/kg midazolam
Group II: 1.0 mg/kg midazolam
Group III: 0.7 mg/kg midazolam+1.0 mg/kg meperidine
Group IV: 0.7 mg/kg midazolam+1.5 mg/kg meperidine
Group V: 1.0 mg/kg midazolam+1.0 mg/kg meperidine
Group VI: 1.0 mg/kg midazolam+1.5 mg/kg meperidine

Nitrous oxide was not used.

Assessment of efficacy and sedation success

A pragmatic approach was utilized in this study to ascertain the effectiveness of sedative agents.

Under optimal circumstances, efficacy and success of a specific management strategy (in this case, a sedation regimen) was implied by the ability to render quality care under circumstances which offers minimal or no interfering movement. Using a sedation record assessment instrument developed by Nathan[49,50,56] joint ratings of sedation effectiveness were made by the operator and the sedation assistant at the conclusion of each visit. Ideal or excellent sedation was defined where treatment was permitted without need for restraint (absence of persistent interfering movement), where the patient remained responsive to verbal stimulation before, during, and following treatment, and where minimal recovery period occurred, during which time the patient could be returned to the custody of an untrained individual experiencing full return to pre-drug levels of responsiveness. Acceptable or adequate sedation was defined where all or most treatment was permitted with minimal need for occasional application of soft restraint for reflexive-type movement with non-intentional interfering movement. Also, criteria for conscious sedation, as per AAPD guidelines, were fulfilled, ie somnolence may occur (arousal, interactive) during and following treatment with minimal recovery before full return to pre-drug levels of responsiveness. The checklist, which was completed after each visit, is illustrated in Table 1.

Table 1. Definitions of Ratings for Sedation Effectiveness[49,50,56]

Excellent sedation
Patient conscious through entire visit; requiring verbal stimulation only
All treatment objectives accomplished
No restraint required
Adequate sedation
Occasional or persistent somnolence requiring mild physical stimulation to arouse
Completed most of treatment objectives
Minimal or limited restraint needed
Inadequate sedation
Persistent somnolence requiring profound physical stimulation for arousal
Persistent restraint needed to treat with difficult interfering movement
Unable to complete reasonable objectives
Over-sedation
Intense physical stimulation needed for arousal (deep sedation)
Partial or complete loss of protective reflexes (deep sedation/GA)
Somnolence which persists through visit requiring lengthy recovery

Assessment of clinical safety

Maintenance of consciousness, in adherence with accepted definitions of levels 2 and 3 of conscious sedation (as per AAPD Guidelines)[51] throughout latent, intra-operative, and recovery periods, was considered minimally necessary to imply clinical safety. Under circumstances of somnolence requiring intense stimulation to reduce depressed levels of consciousness (level 4 deep sedation), partial or complete loss of protective reflexes, frequent or persistent oxygen de-saturations, and/or prolonged recovery would preclude assumptions of clinical safety (in the context of this study). Because induction of level 4 was not anticipated, capnography was not available at the time of data collection.

In addition to the impact of each experimental condition on the level of sedation achieved, the length of recovery time necessary to return to pre-sedation levels of arousal was considered a measure of clinical safety and desirability.

Heart rate measurement during stressful procedures

In an effort to acknowledge less overt manifestations of apprehension in response to stressful stimuli, alterations in heart rate from baselines were recorded. Mean heart rate was recorded during one minute intervals prior to and during the onset of local anesthetic administration and cavity preparation.

Table 2. The Mean Age, Weight, and Time of Onset for Each Experimental Condition

Experimental group	Gender	Age(mos.)	Weight(kg)	Dose(mg/kg)	Time of onset(min)
I	Male 11	30±4	14±2	Midazolam 0.7	21±4
	Female 9				
II	Male 9	30±4	12±2	Midazolam 1.0	21±3
	Female 11				
III	Male 8	33±5	13±2	Midazolam 0.7	25±5
	Female 12			Meperidine 1.0	
IV	Male 9	35±5	14±2	Midazolam 0.7	21±3
	Female 11			Meperidine 1.5	
V	Male 10	38±5*	15±2	Midazolam 1.0	24±5
	Female 10			Meperidine 1.0	
VI	Male 10	39±5*	16±2*	Midazolam 1.0	29±3*
	Female 10			Meperidine 1.5	

*P<0.05, ANOVA

It was hypothesized that well-sedated subjects could be expected to manifest lesser elevations in heart rate compared to subjects where sedation proved inadequate.

Effect on working time and completion of treatment objectives

Of interest to this study was the effect of increasing dosages of midazolam, with and without meperidine, on ensuing operating time. Evidence of expansion of working time (beyond 10-15 minute periods), while fulfilling criteria for consciousness throughout visits, would be useful to establish agent, dosage, and patient demand recommendations for midazolam alone or in combination with meperidine.

Parental assessment

Parents were surveyed at the time of discharge and during a follow-up phone call for their impressions of the sedation visits with respect to comfort levels and inclination to consider or recommend similar sedation for future visits. Recovery parameter questions were asked in the follow-up call to ascertain the occurrence and duration of post-treatment drowsiness and napping following discharge.

Statistical analyses

Analyses used included Chi-square and ANOVA.

Results

The mean age, weight, sex, and duration of onset for each drug condition of the sample of children are displayed in Table 2. Statistical differences between ages were found between pairings of Groups I and II and Groups V and VI (P<0.001).

Efficacy

Comparisons between groups with respect to overall assessment of sedation effectiveness found no statistical differences between Groups II through VI. Inclusion of ratings of "adequate sedation" as a reasonably desirable treatment outcome accounted for success rates which ranged from 80%-100% (Fig 1).

One-way ANOVA found statistically significant differences between Group I and all other groups (P<0.05). When used alone, midazolam (Group I at 0.7 mg/kg) produced at best 40% success (25% excellent, 15% adequate) in contrast to Group II (1.0 mg/kg), where success occurred at 90% (60% excellent, 30% adequate), as seen in Fig 1.

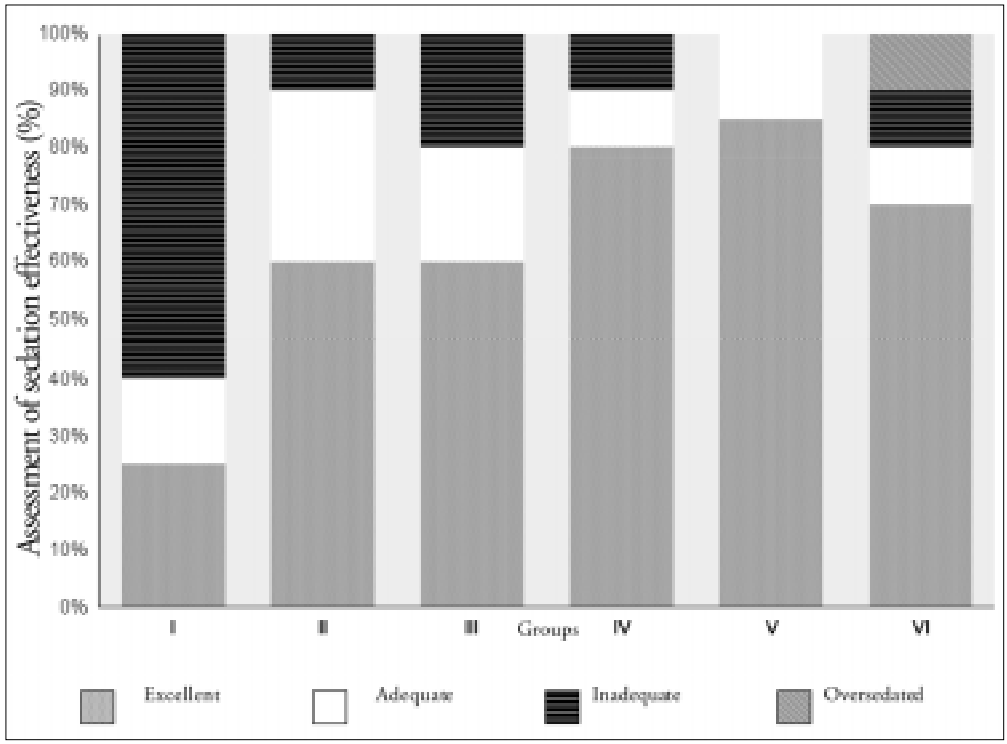

Fig 1. Overall effectiveness of sedation

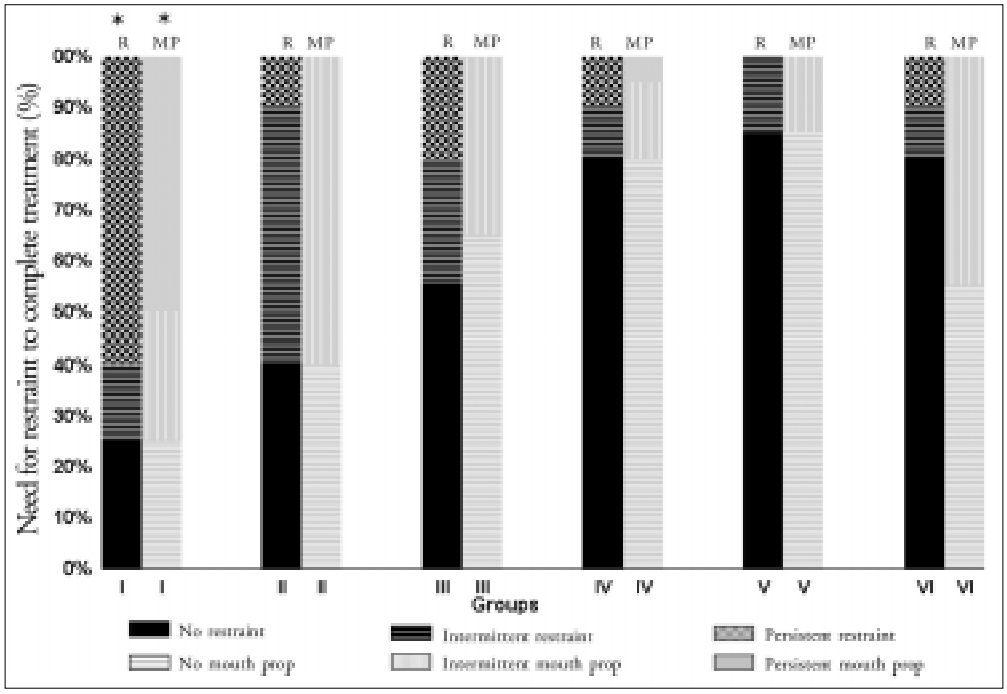

Fig 2. Need for physical restraint and mouth opening. *P<0.05; R=restraint; MP=mouth prop.

One-way ANOVA for heart rate changes revealed statistical differences for Groups V and VI only during cavity preparation. Figures 3A and 3B illustrate the extent to which elevations in heart rate over baseline periods occurred. Elevations were greatest for Groups I and III. Comparison of group trends appear to be consistent with sedation effectiveness but are not conclusive.

Safety and recovery

There were no episodes of persistent oxygen de-saturation, loss of protective reflexes, respiratory depression, or emesis. Transient episodes of oxygen de-saturation occurred in Groups II (2), III (1), V(1), and VI(2). None were found to be of consequence or significance requiring intervention. A consistent and most significant finding with respect to safety issues was the extent to which subjects remained conscious (responsive to verbal requests) through latent, intra-operative, and immediate post-treatment periods.

Differences (P<0.05) were found for Groups IV, V, and VI with respect to the length of time elapsed before discharge criteria were met following completion of treatment (Fig 4). Only two subjects from Group VI manifested persistent somnolence during the recovery period and were later

Group V manifested the most striking differences in sedation effectiveness over all other groups (Fig 1). Significant differences were not found between the remaining groups. However, descriptive analysis of clinical significance reveals apparent differences between Group V vs. others with respect to efficacy. Twenty of 20 subjects demonstrated excellent or adequate sedation requiring minimal need (15%; Fig 2) for brief application of body restraint or forcible mouth opening. Near comparable success was achieved in Groups IV and VI. The need or use of higher doses of both medications (Group VI) did not result in better overall ratings of sedation. Ten percent proved inadequate and another 10% experienced level 4 (deep) sedation.

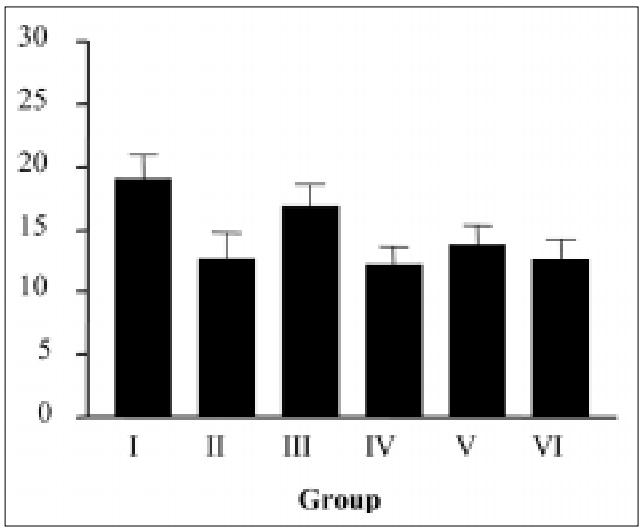

Fig 3a. Change in heartrate during local anesthesia

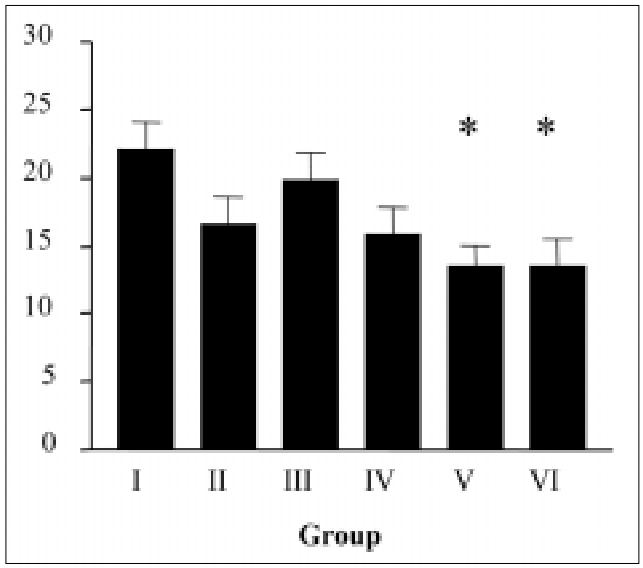

Fig 3b. Change in heartrate during operative procedures. *P<0.05.

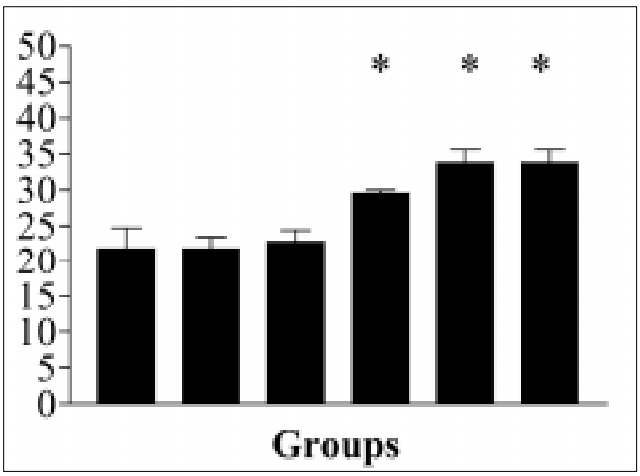

Fig 4. Time before discharge criteria met (min). *P<0.05.

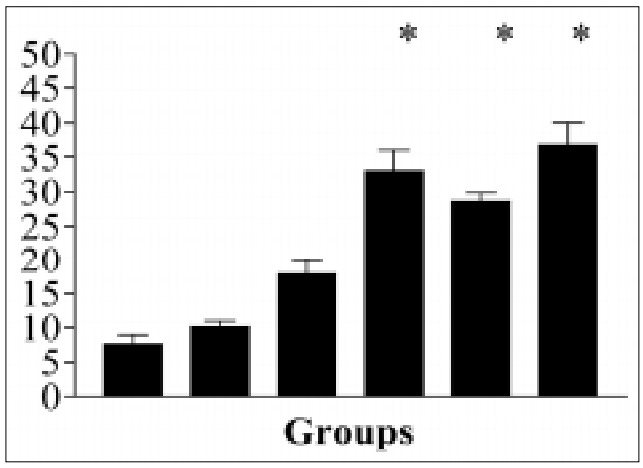

Fig 5. Length of working time (min). *P<0.05.

reported by parents to experience longer than "normal" naptimes.

Effect on working time and opportunity to complete treatment objectives

Differences in working time were significant (P<0.05) for Groups IV, V, and VI (Fig 5). When used alone, midazolam experienced ultra-short duration of action (less than 10 minutes) in comparison to 35-45 minute periods for meperidine groups. Considerable restorative, pulpal, and surgical treatment was permitted by the addition of meperidine in comparison to non-meperidine groups. For approximately 50% of Group I, treatment efforts were either aborted or accomplished under conditions of persistent restraint so as to prevent injury. Decisions to abort were made jointly by practitioner and parent.

Parental assessment

Understandably, parental perceptions of comfort level, safety, and willingness to consider similar sedation techniques for future visits diminished with the onset of somnolence and increasing recovery periods while in–office. Lengthy post-discharge naptime further contributed to parental concern and discomfort. Parents assessment ratings ranged from "no hesitation" to "consider sedation for future visits" to "never-again." The vast majority of sentiment was that sedation seemed very safe and preferable to restraining their child against their will. With the exception of two parents, all expressed approval and willingness to consider this form of sedation again. Overall, approximately 20% expressed that they remained apprehensive about its use but agreed it significantly benefited their child.

Discussion

Pre-cooperative children, by virtue of brief attention spans, restricted range of coping skills, and volatile response patterns when exposed to stress often require pharmacologic intervention to permit invasive and unpleasant treatment. Due to significant risk and prohibitive costs associated with unconscious techniques or deeper levels of sedation, the need exists to develop safe and cost-effective regimens that maintain patient consciousness and overcome non-coping and resistive behaviors to permit in-office care.

To circumvent problems associated with long-acting and dose-related somnolence[31,49,50,52-55] which accompanies agents such as chloral hydrate (when using oral dosages of 50-100 mg/kg), midazolam has emerged as a potential alternative because of its rapid onset, potency to obtund difficult young patient resistance, and perceived range of safety. Data to substantiate dosage ranges for midazolam and its combinations that ensure consciousness in the young pediatric patient before, during, and following treatment is needed.

Midazolam has become a standard pre-general anesthetic regimen for surgical and invasive diagnostic medical procedures for young children. Its ability to render a severely apprehensive young child quiescent in a potentially stressful medical environment gives credence to its applications to pediatric dental management. Earlier agents also possessing similar calming capacities for this population (eg alphaprodine) have been discarded in large part due to clinician failure to acknowledge their propensity to suddenly and profoundly diminish respiratory function. Without sacrificing behavioral-modifying capacity or adversely affecting respiratory or circulatory function, midazolam appears to offer a significant advantage.

Expectations for midazolam used alone

Comparisons between Group I and II suggest that, when used alone, the higher (1.0 mg/kg) dose of midazolam can be expected to produce more effective levels of sedation for severely apprehensive subjects. Age-related differences in behavioral expectations and adaptation to stress, however, can be expected to play a role in drug and dosage selection decisions between pre-cooperative subjects and those above 36 months of age.[13,31,56] For example, children below the age of reason may require deeper levels of consciousness to permit invasive procedures, whereas older subjects more experienced in coping with stress, greater capacity to learn from experience, and differing temperament may need lower dosages and hence lesser degrees of depressed consciousness.

An age discrepancy of approximately 10 months was found to exist between group pairings of Groups I and II and Groups V and VI (Table 2). The impact of such is not clearly explained with respect to interpretation of drug differences between single agents for very young subjects versus the combination for children 10 months older. From a clinical perspective, the range of behavioral differences between a 30 and 39 mos old or 33 and 44 mos old are not expected to be significant.[44] All are potentially volatile; some have the capacity to respond more favorably than others. There may be a tendency to opt for a single agent for subjects under the age of three. It might also be hypothesized that differences in patient responses of a 29 vs 39 mos old would be no more different from the differences between a practitioner's judgment as to how to best manage moderately to severely resistive behaviors for either age.

There were no statistical differences between subjects in Groups I, II and III with respect to age (mean age of subjects in Groups I and II was 29±4 mos; 32±4 mos for Group III); had subjects in Groups I and II been similar to Groups V and VI (mean age 38±5 mos), it is unclear whether or not the higher dose of midazolam alone would have been necessary for short duration procedures. In the absence of untoward reactions, over-sedation or somnolence, or oxygen de-saturation, it is concluded that 1.0 mg/kg is safe. It is nevertheless conceivable that dosages of 0.7 mg/kg or less may prove effective for older subjects (>36 mos) with greater cognitive and coping abilities, or conversely, for subjects simply with lower levels of apprehension or invasiveness of treatment need. The frequency with which 0.7 mg/kg produced sufficient sedation (40%) with working times of 7±5 minutes suggests that subjects in this sample manifested severe or heightened levels of pre-treatment anxiety. Confronting such levels of resistance, improvement in efficacy with the use of 1.0 mg/kg midazolam (with and without meperidine) reached statistical significance, (P<0.001).

Comparisons of Groups I and II

An interesting finding of the study was that the addition of meperidine (1.0 mg/kg) doubled efficacy with 80% of the visits showing adequate or better ratings without adverse occurrences or delay in recovery. Similarly, its addition resulted in doubling of working time from 8±5 to 18±9 minutes.

Comparisons of meperidine Groups III, IV, V, and VI

While statistically significant differences were not found between Groups IV-VI, descriptive analyses suggest that differences significant to clinician judgment exist when selecting dosage. The occurrence of oversedations in Group VI, excessive working times with corresponding long recovery periods and prolonged somnolence suggests that use of a higher meperidine dose is unwarranted, if not simply ill-advised (assuming induction of level 4 sedation is not intended). Conclusions of safety, conversely, need not exclude level 4.

Clinicians utilizing sedative techniques must recognize the potential of any regimen to inadvertently induce deeper levels of sedation than intended. Proficiency and preparedness to manage adverse airway or alteration in vital signs are minimal qualifications for the clinician utilizing in-office techniques. An inability to recognize and appropriately respond to the monitoring and support demands of sedated patients renders utilization of such techniques as unsafe.

Defining success of oral sedation regimens

The behavioral research literature is replete with methods that offer detailed and complex mechanisms in which to assess efficacy and success of a given intervention.[46-48] Such composite indices have included various self-report measures, behavioral observation ratings, and physiologic parameters. The demand for multiple measures to depict slight differences in patient response patterns becomes apparent when response variability is in fact subtle.

In the present study, assessment of clinical efficacy of a sedation regimen was reduced to a simplistic denominator, ie, the extent to which persistent physical restraint was needed to complete treatment.[49,50] Efficacy and success of a specific management strategy (in this case a sedation regimen) is implied by the ability to render quality care under circumstances which offer minimal or no interfering movement and physical resistance. It would seem logical to assume that need for restraint of a persistent nature would reflect an inadequate (albeit not necessarily unsafe) level of sedation. Need for transient application of restraint to prevent injury from occasional reflex-type movements, however, was not construed as a detriment to clinical efficacy or sedation success.

While some earlier pediatric sedation trials have arbitrarily included or mandated the use of restraining devices within their methods, their use was excluded intentionally in this study. The ability to differentiate and infer sedation effectiveness from the frequency and intensity of patient movement is an important distinction in studies which focus on drug effect. Application of restraining devices renders interpretation between resistive movement being the result of inadequate sedative effect, patient frustration, or a preference not to be bound, as difficult at best. Similarly, distinctions between quiescence that results from drug effects vs fatigue related to struggle to escape impairs interpretation from the outset. Elimination of this obstruction to assessment of drug effects therefore seems desirable.

Need appears to exist for controlled data which supports the efficacy and safety of various oral sedation regimens. With few exceptions, research methods have been employed which incorporate confounding drug comparisons, poorly defined patient selection criteria, and ambiguous definitions of success. This latter issue and its implications toward assessment of sedation effectiveness is an integral component of this study.

What constitutes success does vary among parents and practitioners. Factors such as medical status and fiscal

concerns may determine from a practical perspective how critical it becomes to avoid general anesthesia. For some, it is conceivable that merely completing treatment by application of physical restraint, with or without sedative medication if it avoids the need for general anesthesia or more profound (deep) sedation, constitutes success. For others, use of physical restraint to manage a neurologically normal child is not an acceptable option. Where parental expectations do not restrict the use of physical restraints minimally effective sedative medication can be construed as a successful strategy. However, when the decision to make use of a sedative technique is made on the basis of perceived unacceptability of aversive techniques, then failure to overcome need for restraints by use of inadequate sedation cannot be construed as therapeutic success.

Rationale for the intentional exclusion of physical restraint in the context of this study served to permit a simplified approach to ascertain actual drug capacity to overcome disruptive behaviors. This issue recognizably remains conceptual, if not purely theoretical, in its origin. On the other hand, no data currently exists to identify the effect restraining devices or the effect of physically restraining a child has on subsequent child behaviors or their impact on sedation effectiveness. Focusing solely on the ability of oral doses of midazolam with and without meperidine to obtund or overcome refractory behaviors without resorting to the application of restraint serves to enhance our ability to assess drug efficacy while minimizing/eliminating a potentially confounding variable.

Limitations of the study

The limitations of the study are consistent with the characteristics of retrospective investigations. The need for blind and controlled conditions and a prospective design is warranted. Comparison of subjects with and without previous dental experience with refined subject selection criteria might be considered. The inclusion of additional physiologic parameters such as respiratory rate, mean arterial pressure, and capnography would contribute further to evidence of patient safety. Additional group comparisons using alternate dosages might be considered. For example:

0.5 mg/kg midazolam+1.0 mg/kg meperidine
1.0 mg/kg midazolam+0.5 mg/kg meperidine
0.5 mg/kg midazolam+1.5 mg/kg meperidine

Similarly, comparisons of midazolam with varying concentrations of nitrous oxide/oxygen to midazolam dosages with meperidine might be considered. Comparisons of midazolam-meperidine vs. midazolam-morphine or acetaminophen would provide additional information regarding the usefulness and safety of this primary agent for pediatric management.

Future studies may consider inclusion of additional experimental groups in which physical restraints are applied. Such studies would permit meaningful comparisons between drug effects and the impact of utilization of restraint.

Conclusions

1. When oral midazolam is used as the sole agent for managing severely apprehensive young patients, 1.0 mg/kg is likely to be significantly more effective than 0.7 mg/kg for short procedures.
2. The addition of meperidine appears safely to enhance the efficacy and duration of action of midazolam. Its potentiating effect, while producing more predictable and longer lasting effects, may enable reduction in dosing of midazolam.
3. Potential exists for the combination of midazolam and meperidine in higher doses to increase the risk of inducing deep sedation and prolong recovery.

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Abstract of the Scientific Literature

Morphological and Positional Asymmetries of Young Children with Functional Unilateral Posterior Crossbite

This study evaluated the morphological and positional mandibular asymmetry of young patients with functional unilateral posterior crossbite. The sample included 15 children (8.8±1.0 years of age) pre- and post-treatment. Each patient had a complete unilateral posterior crossbite involving 3 or more posterior teeth, a functional shift from centric relation-intercuspal position, and no signs or symptoms of temporomandibular disorder. A bonded palatal expansion appliance was used to rapidly expand the maxilla (1 month) retention for 6 months. Articular joint spaces were assessed using zonograms, and submental vertex radiographs were used to assess morphological and positional asymmetry. The results showed that the mandible was significantly longer on the noncrossbite side than it was on the crossbite side. The asymmetry was most evident for the ramus and involved both the condylar and the coronoid processes. The posterior and superior joint spaces were larger on the noncrossbite side than they were on the crossbite side. After treatment and retention, the mandible showed no significant morphological asymmetries. Mandibular growth was greater on the crossbite side than it was on the noncrossbite side, and the mandible had been repositioned; the crossbite side had rotated forward and medially toward the noncrossbite side. The conclusions suggest that unilateral posterior crossbites produce morphological and positional asymmetries of the mandible in young children, and that these asymmetries can be largely eliminated with early expansion therapy.

Comments: Early expansion therapy is recommended to correct functional unilateral posterior crossbites, and the treatment and retention time is short. **AOC**

Address correspondence to PH Buschang Department of Orthodontics, Baylor College of Dentistry, Texas A&M University System, Dallas, TX 75246. phbuschang@tambcd.edu

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