PEDIATRIC DENTISTRY/Copyright ©1985 by
The American Academy of Pediatric Dentistry
Volume 7 Number 4

Evaluation of the sedative effect of rectally administered diazepam for the young dental patient

Catherine M. Flaitz, DDS, MS Arthur J. Nowak, DMD, MA

Abstract

Rectal diazepam was evaluated for its sedative effect on the difficult-to-manage child in the dental setting. A placebo was used as a control. In a double-blind study, 12 uncooperative patients with a mean age of 3.75 years were selected using the Frankl scale, Ratings 1 and 2. Each child was seen for an initial examination and 2 standardized restorative treatment visits. Randomly, a dosage of 0.6 mg/kg of either diazepam or sodium chloride was dispensed through a soft, rubber catheter. Videotapes were recorded for both treatment visits on all children during a specific 6-min segment. These were reviewed later by 3 judges using a kinesics/vocalization instrument. The results of this study indicated that rectal diazepam (0.6 mg/kg) is an effective, predictable, and safe sedative which adapts well to the routine dental appointment for the young pediatric dental patient.

Patient management provides the pediatric dentist with unique responsibilities to help the child make appropriate emotional and behavioral responses. Although most young children are able to control their behavior adequately in the dental setting,[1] there are certain apprehensive patients who are management problems for the most experienced clinician. For some of these anxious children, pharmacological adjuncts are a temporary method for safely and efficiently rendering quality oral health care.

A wide variety of medications have been recommended for managing the anxious child, but there are few controlled investigations evaluating behavior-modifying drugs for use in the dental setting. Diazepam is one agent that has been used with some frequency by pediatric dentists.[2] Although the antianxiety property of diazepam has been described in many clinical studies, evidence supporting its benefits in pediatric dentistry has been equivocal and varies with the route of administration.[3-6]

The most common routes for administering diazepam during dental treatment are intravenous (IV) and oral. The rectal approach, using diazepam in solution, has some advantages. Since diazepam is highly lipophilic, it is absorbed rapidly through the mucosal membranes of the colon. For this reason, the rectal route is the second most rapidly absorbed method in children.[7-9] When this method is compared to oral administration, a faster and more reliable peak plasma concentration is obtained per rectum. Peak serum levels, when administering diazepam rectally, are obtained within 5-10 min in children, with small individual differences.[7,10] The same medication given orally reaches a peak plasma level within 30-90 min on the average,[11] exhibiting up to a 30-fold individual variability.[12] In addition, the clinical duration of action, when given rectally, compares more favorably with a pediatric dental appointment. Sedative effects have been observed up to 120 min for oral administration,[13] whereas this effect is decreased to 60 min using the rectal approach.[6]

Although IV diazepam has proven to be a satisfactory sedative in dentistry, it has its limitations in pediatric dentistry. Despite its more rapid attainment of peak plasma levels in 1-5 min[14] and shorter acting sedative effect of 45 min,[15] it requires patient cooperation for administration. For the difficult-to-manage child unable to cope with anxiety-provoking stimuli, this route may be traumatic. Furthermore, overt body movement by the patient could displace the IV needle. Rectal diazepam has been shown to be an effective and practical alternative with blood levels as high as 80% of that attained intravenously.[7]

The purpose of this study was to evaluate the sed-

ative effect of rectal diazepam on the behavior of uncooperative pediatric dental patients when compared to a placebo. A kinesics/vocalization instrument was used to measure the behavioral responses of the child and operator in the dental setting.

Methods and Materials

The patients in this study included 12 children between 2- and 6-years-old (mean age, 3.75). Selection of these difficult-to-manage pediatric patients was made at an initial examination visit by pediatric dental faculty. All children were identified as being negative or definitely negative toward dental treatment as defined by the Frankl scale, Ratings 1 and 2.[16] Minimum treatment requirements for the children were 2 Class I alloy restorations on primary molars.

The investigation was conducted using a double-blind design in which neither the dental operator nor child were aware of the agent dispensed. Each patient was required to return to the dental clinic for 3 separate appointments, including the initial examination visit and 2 treatment visits. The children were divided randomly into 2 groups. Group A received the placebo at the first appointment and diazepam at the second, while group B received diazepam at the first appointment and the placebo at the second. The children were instructed to ingest nothing 4 hr prior to the treatment visits as a precautionary measure against vomiting and aspiration.

A sedative dose of 0.6 mg/kg of diazepam[a] in solution was administered because of the satisfactory sedative effects, reported by Lundgren et al. in the young pediatric dental patient.[6] This predetermined dosage of diazepam was drawn up into a 3 cc plastic syringe. After the needle was removed from the syringe, a soft rubber catheter was attached to the hub, and the tip of the catheter was coated with a lubricating jelly for easy insertion. The child lay over the knees of the parent to aid in administration. After dispensing the medication per rectum, a bolus of air was used to clear the remaining contents of the syringe. In a similar manner, bacteriostatic sodium chloride was drawn up for the placebo.

The agents were administered by a pediatric dentist in a standardized operatory, equipped with an overhead camera. The same dentist and dental assistant were responsible for patient treatment and management. The dentist was unaware of the agent administered to the child prior to treatment.

The restorative procedure was initiated 10-15 min after administering the medication. Every appointment was videotaped and later divided into six 1-min segments for future evaluation. The first 3 min of the film included the local anesthetic injection and the period immediately following. The fourth minute coincided with rubber dam application, the fifth started with cavity preparation, and the final minute included the condensation and carving of the amalgam restoration. Blood pressure and pulse were recorded 4 times during the appointment by the dentist.

The videotapes were reviewed by 2 pediatric dentists and a dental assistant utilizing the kinesics/vocalization instrument.[17,18] The 6 behavioral categories evaluating the child's responses included:

1. Head and oral movements
2. Upper extremity movements
3. Torso movements
4. Lower extremity movements
5. Vocalizations by the patients
6. Requests and commands by the dentist.

The patient's movements were subdivided into interfering and noninterfering behavior. Interfering behavior was defined as those actions which produced a disruption in the clinical procedure, while noninterfering behavior was judged to be inconsequential to treatment progress.

Each evaluator reviewed the filmed treatment appointment and independently recorded the child's behavioral responses and dentist's voice commands during the specified 6-min periods. An audible tone was incorporated into the soundtrack of the film which divided each minute into 10-sec intervals to quantify the duration of the behavioral responses. The minimum number of responses for each behavioral category during the 6-min filmed segments was 0 and the maximum was 36. Videotapes of these treatment appointments were reviewed up to 6 times in order to record all the behavioral responses correctly. After final viewing of the filmed treatment appointment, evaluators assigned a Frankl scale rating to the entire procedure.

Analysis of variance (ANOVA) was used to examine the sedative effect of diazepam and placebo on the children's behavior during the treatment visits. A significance level of $p \leq 0.05$ was considered acceptable. Tables illustrating the means of these treatment groups were constructed for the 6 behavioral responses defined by the kinesics/vocalization instrument. The Pearson's Product-Moment Correlation Test was utilized to compare the Frankl scale ratings with the kinesics/vocalization instrument. The significance

[a] Valium® (diazepam) package insert, 1979 — Roche Laboratories, Division of Hoffman-LaRoche, Inc: Nutley, NJ. The diazepam solution administered to the children was Valium® Injectable. As described by the package insert: Each ml contains 5 mg diazepam compounded with 40% propylene glycol, 10% ethyl alcohol, 5% sodium benzoate and benzoic acid as buffers, and 1.5% benzyl alcohol as preservative.

level for this test was $p \leq 0.05$. The reliability of the kinesics/vocalization instrument and the Frankl scale rating was analyzed using the interrater reliability coefficient.

Results

Statistical analysis showed that a significant difference was identified for the effect of sedative management on the behavior of the young patient. All interfering patient movements, patient vocalizations, and operator commands/requests were reduced significantly when diazepam was administered during dental treatment (Tables 1, 2). In addition, this difference for all interfering movements was observed for the entire appointment (Table 3).

In contrast, this drug effect was not observed for noninterfering movements during the treatment appointments. The number of noninterfering bodily movements was similar during both restorative appointments (Table 4).

Two instruments were used in this study to measure pediatric behavior during a dental appointment. When comparing the 2 behavioral instruments, a significant correlation between the global Frankl scale and the kinesics/vocalizations instrument was identified (Table 5). The reliability of each instrument was deemed satisfactory.

Clinical evaluation of rectally administered diazepam was rated acceptable to excellent by the operator. All patients receiving diazepam during the treatment appointment were managed safely to completion, as opposed to abandonment of treatment in 2 cases with the placebo.

Side effects were recorded by the operator during the appointment and by the parents after the treatment visits. The majority of effects were present in the diazepam treatment group and included anterograde amnesia, ataxia, hypotonicity, and drowsiness. These effects were considered favorable during the appointment and were dissipated greatly within the first hour. No significant differences in blood pressure and pulse were demonstrated between the 2 treatment appointments.

Table 1. Total Interfering Movements: Mean Values[1]

Treatment	Head/Oral	Upper Extremities	Lower Extremities	Torso
Diazepam N = 12	1.67*	2.72*	0.33*	0.83*
Placebo N = 12	9.50	9.11	5.72	7.33

* Significant difference between diazepam and placebo treatment at $p \leq 0.0001$ ANOVA.

[1] Possible score: minimum = 0; maximum = 36 for each category of movement.

Table 2. Total Vocalizations: Mean Values[1]

Treatment	Patient	Operator
Diazepam N = 12	7.39*	5.83*
Placebo N = 12	17.08	12.61

* Significant difference between diazepam and placebo treatment at $p \leq 0.0001$ ANOVA.

[1] Possible score: minimum = 0; maximum = 36 for each category of vocalization.

Discussion

Rectally administered diazepam in solution was selected for this study because of its reported sedative effects and high margin of safety when given to young children for febrile convulsions.[19,20] Although diazepam has been examined for its clinical efficacy in relieving anxiety during dental treatment, only 1 study has evaluated the benefits of administering this medication per rectum to the young pediatric dental patients.[6]

Diazepam is classified as a central nervous system (CNS) depressant, acting primarily on the limbic system by means of inhibition. This preferential depressant action on the subcortical structures of the CNS

Table 3. Interfering Movements During Treatment: Mean Values[1]

Treatment	Injection Pre-	Injection During	Injection Post-	Rubber Dam	Cavity Preparation	Alloy Placement
Diazepam N = 12	0.39*	2.17*	1.53*	0.78*	0.47*	0.22*
Placebo N = 12	3.67	5.56	4.36	6.75	5.72	5.61

* Significant difference between diazepam and placebo treatment at $p \leq 0.0001$ ANOVA.

[1] Possible score: minimum = 0; maximum = 36 for each 1-min segment.

Table 4. Total Noninterfering Movements; Mean Values[1]

Treatment	Head/Oral	Upper Extremities	Lower Extremities	Torso
Diazepam N = 12	8.50	11.05	2.58	11.89
Placebo N = 12	7.64	11.00	2.86	11.75

No significant differences between diazepam and placebo treatment at $p \leq 0.05$ ANOVA.

[1] Possible score: minimum = 0; maximum = 36 for each category of movement.

Table 5. Correlation Between Frankl Scale Ratings and the Kinesics/Vocalization Instrument

	Total Movements		Vocalizations	
Variable	Noninterfering	Interfering	Patient	Operator
Correlation Coefficient	−0.157	−0.702*	−0.926*	−0.744*

* Significant difference indicates positive correlation between kinesics/vocalization instrument and Frankl scale at $p \leq 0.0001$ – Pearson's Produce-Movement Correlation Test.

is accomplished without significantly altering respiratory, autonomic, or extrapyramidal activity.[21] In this clinical study 0.6 mg/kg of diazepam, rectally administered, provided adequate sedation in these children during dental treatment without lowering the patients' sensory perception, responsiveness, or alertness to an unsafe degree. There were no clinically significant changes in blood pressure or pulse nor signs of marked drowsiness or lethargy.

The onset and duration of action were practical for use in the routine dental setting. The average onset of action was 12 min with a range of 8-15 min. The clinical duration of action allowed for a simple, restorative procedure to be completed successfully. Within the first hour, all children could be dismissed with parental supervision because they were alert and responsive. These clinical findings were similar to those reported by Lundgren et al.[6]

The side effects in this study were similar to those described by other investigators of rectally administered diazepam in the pediatric child patient.[6-9,22] The majority of the children experienced hypotonicity, mild ataxia, and varying levels of sedation. During the restorative appointment, muscle relaxation and drowsiness contributed to a more favorable working environment. Even when the patient was not ideally cooperative, his movements lacked purpose and were controllable. No adverse affects were noted during the diazepam treatment appointments, although the possibility of respiratory depression has been discussed due to the rapid absorption rate of diazepam.[6,7,22]

The most valuable property of rectally administered diazepam in pediatric dentistry is its antianxiety effect. Most of the children tolerated the simple operative procedure with an increased level of cooperation as measured by the kinesics/vocalization instrument. Although some children were more calm and relaxed than others, all dental treatment could be completed successfully for the 12 children when diazepam was administered.

Rectal drug administration is not a popular route for medicating children in dentistry;[2] however, in this study the rectal administration of diazepam was not only satisfactory but also advantageous for several reasons. It was easy to administer, required minimal patient cooperation, and was painless. Absorption was not affected by the contents of the stomach nor by delayed gastric emptying due to the vasoconstrictive effect produced by fear. In addition, the dentist was assured that the child received the intended dose and was monitored properly.

The major disadvantage of rectal diazepam was that the drug could not be titrated to obtain the ideal level for sedation for each child. Also, impaction of fecal material or expulsion of the solution from the rectum could produce variable results. In this study, problems were decreased by using a soft rubber catheter that did not penetrate the contents of the bowel easily and by squeezing the buttocks together after removing the catheter.

The kinesics/vocalization instrument proved to be a valid method for measuring the difference between the sedative effect of diazepam and placebo. This behavioral instrument differentiated between interfering and noninterfering movements during treatment and aided in discriminating between the type of responses that would disrupt treatment and the frequency of those behaviors. It was interesting to observe that all children engaged in an acceptable range of body movements which aided in evaluating the level of sedation attained. This amount of activity was necessary in order to assist the dentist in successfully performing the treatment procedures.

During each of the six 1-min intervals, all interfering movements were decreased significantly in the diazepam treatment group. This verified that the onset of action was approximately 15 min after administration and that it was effective throughout the appointment. In addition, this behavioral instrument demonstrated that these difficult-to-manage children remained uncooperative throughout the entire treatment visit and not just during injection of the local anesthetic.

When comparing the two behavioral evaluation instruments, some interesting relationships were observed. Patient vocalizations, followed by interfering head/oral and upper extremity movements correlated

the highest with Frankl scale ratings. This relationship was not found for noninterfering movements. This indicated that both the kinesics/vocalization instrument and Frankl scale were measuring the salient features of uncooperative behavior in dentistry. The kinesics/vocalization instrument described specifically those body regions of patient movement that impede a dental procedure and when the most activity occurred. In contrast, the Frankl scale allowed the evaluator to focus on relevant cues, as defined by this behavioral scale, and arrive at a descriptive, overall impression about the child's behavior.

Conclusion

Rectally administered diazepam significantly decreased all forms of disruptive behavior during dental treatment in young pediatric patients when compared to a placebo, as measured by the kinesics/vocalization instrument. The weight basis dosage of 0.6 mg/kg provided a predictable and safe level of sedation with minimal side effects. In addition, the onset and duration of action of rectal diazepam adapted well to the usual time frame for a pediatric dental appointment. This nontraditional route for administering diazepam exhibited desirable sedative properties without a traumatic induction.

Dr. Flaitz is in private practice, pediatric dentistry, in Westminster, Colorado, and is a clinical assistant professor, growth and development, School of Dentistry, University of Colorado Health Sciences Center (Box C-284), Denver, CO 80262. Dr. Nowak is a professor, pediatric dentistry, The University of Iowa. Reprint requests should be sent to Dr. Flaitz.

1. Fields HW, Machen JB, Chambers WL, Pfefferle JC: Measuring selected disruptive behavior of the 36- to 60-month-old dental patient, II: Quantification of observed behavior. Pediatr Dent 3:257–61, 1981.
2. Wright GZ, McAulay DJ: Current premedicating trends in pedodontics. J Dent Child 40:185–87, 1973.
3. Hargreaves JA: Pharmacotherapeutic approaches to behavior management - Valium, in Behavior Management in Dentistry for Children, Wright GZ, ed. Philadelphia, PA; WB Saunders Co, 1975 pp 159–63.
4. Healy TE, Hamilton MC: Intravenous diazepam in the apprehensive child. Br Dent J 130:25–27, 1971.
5. Brown PR, Main DM, Lawson JI: Diazepam in dentistry. Br Dent J 125:498–501, 1968.
6. Lundgren S, Ekman A, Blomback U: Rectal administration of diazepam in solution. A clinical study on sedation in paediatric dentistry. Swed Dent J 2:161–66, 1978.
7. Agurell S, Berlin A, Ferngren H, Hellstrom B: Plasma levels of diazepam after parenteral and rectal administration in children. Epilepsia 16:277–83, 1975.
8. Knudsen FO: Plasma diazepam in infants after rectal administration in solution and by suppository. Acta Paediatr Scand 66:563–67, 1977.
9. Langslet A, Meberg J, Bredesen JE, Lunde PK: Plasma concentration of diazepam and N-desmethyldiazepam in newborn infants after intravenous, intramuscular, rectal, and oral administration. Acta Paediatr Scand 67:699–704, 1978.
10. Magnussen I, Oxlund HR, Alskirk KE, Arnold E: Absorption of diazepam in man following rectal and parenteral administration. Acta Pharmacol Toxicol 45:87–90, 1979.
11. Mandelli M, Tognoni G, Garattini S: Clinical pharmacokinetics of diazepam. Clin Pharmacokinet 3:72–91, 1978.
12. Gamble JA, Mackay JS, Dundee JW: Correspondence: plasma levels of diazepam. Br J Anaesth 45:1085, 1973.
13. Baird ES, Hailey DM: Delayed recovery from a sedative: correlation of the plasma levels of diazepam with clinical effects after oral and intravenous administration. Br J Anaesth 44:803–8, 1972.
14. Kaplan SA, Jack ML, Alexander K, Weinfeld RE: Pharmacokinetic profile of diazepam in man following a single intravenous and oral and chronic oral administration. J Pharm Sci 62:1789–96, 1973.
15. Foreman PA: Control of the anxiety/pain complex in dentistry. Oral Surg 37:337–49, 1974.
16. Frankl S, Shiere FR, Fogels HR: Should the parent remain with the child in the dental operatory? J Dent Child 29:150–63, 1962.
17. Smith RC: Chloral hydrate sedation in dentistry for children with handicaps. MS thesis, The University of Iowa, 1977.
18. Nowak AJ, Smith RC, Kerber PE: Development and testing of an instrument to measure patient kinesics. J Dent Res 58:323, 1979.
19. Gururaj VJ: Febrile seizures: current concepts. Clin Pediatr 19:731–38, 1980.
20. NIH: Consensus Development Conference on Febrile Seizures, Febrile seizures: long-term management of children with fever-associated seizures. Pediatr 66:1009–12, 1980.
21. Tallman JF, Paul SM, Skolnick P, Gallager DW: Receptors for the age of anxiety: pharmacology of the benzodiazepines. Sci 207:274–81, 1980.
22. Dulac O, Aicardi J, Rey E, Olive G: Blood levels of diazepam after single rectal administration in infants and children. J Pediatr 93:1039–41, 1978.