

Comparison of a computerized anesthesia device with a traditional syringe in preschool children

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Abstract

Purpose: The purpose of this investigation was to evaluate the efficacy of a computerized injection device (Wand) on reducing pain behavior during injections with preschool-aged children.

Methods: Subjects consisted of 40 patients between the ages of 2 and 5 requiring local anesthesia for dental restorations in the maxilla. Patients were randomly assigned to either the Wand or the traditional anesthetic delivery system. A palatal approach to the anterior and middle superior alveolar nerves and the anterior superior alveolar nerve was used with the Wand injections. Buccal infiltration and palatal injections were used for the traditional method. Pain behavior was observed and coded.

Results: Results of Fisher Exact tests found that using the Wand to deliver anesthetic lead to significantly fewer ($P < .01$) disruptive behaviors in preschool-aged children when compared with a traditional injection regimen. In addition, none of the preschool-aged children exposed to the Wand required restraint during the initial interval, while nearly half of the children receiving a traditional injection required some type of immediate restraint.

Conclusions: These results demonstrate that the Wand can significantly reduce disruptive behaviors in a population of young children who are traditionally more difficult to manage and may be one method of creating a more positive experience for the young child and the practitioner. (*Pediatr Dent.* 2002;24:315-320)

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Although many children seen in clinical practice are very good patients,¹ nearly one in four present with some type of management challenge.² In addition, management problems are strongly correlated with age, where younger, preschool-aged children are more challenging in the dental clinic than school-aged children. Furthermore, management problems are compounded when invasive procedures are required. Indeed, data from private practice suggests that the younger the child and the more threatening the procedure, the more often negative behavior is observed.³ Perhaps not surprisingly, preschool children can be so difficult to manage that many general practitioners are not willing to provide care for them when anything more than an examination or prophylaxis is required.⁴ This is of

particular concern given the recent interest in increasing preschool children's access to dental care.⁵⁻⁷

One way to reduce management difficulties in preschool-aged children is to explore strategies for reducing the pain and discomfort associated with invasive restorative dental procedures.^{8,9} For example, numerous studies have been conducted to achieve a painless injection,¹⁰⁻¹² including the use of topical anesthesia and prolonged injection time.¹³

Prolonged injection time has been pursued as a means of reducing the pain associated with an injection because it is understood that pain is created, at least in part, by the volume pressure changes exerted by the injected solution on small nerve fibers.¹⁴⁻¹⁵ Slowing the rate of administration may be one method of controlling the volume pressure.

However, it can be technically difficult to achieve when done manually.¹⁶

Recently, several controlled investigations with school-aged children have been conducted exploring the efficacy of a computerized local anesthetic delivery system designed to reduce the pain of the injection by delivering anesthetic at a constant rate, pressure and volume. The first investigation was a controlled study using two groups of children with randomized assignment. One group received a traditional anesthesia injection and the other group received injections via the computerized "Wand" system.¹⁷ The Wand was not found to offer any specific benefit. However, this first investigation did not control for inherent differences in the duration of the two different injection methods, and the investigators also failed to target injection sites specifically recommended by the manufacturer.

In a subsequent controlled study designed to address these problems, the Wand was indeed found to produce significantly fewer disruptive behaviors (such as being less likely to cry or move) in children during the initial 15 seconds of an injection.¹⁸ In addition, children who experienced traditional injections were five times more likely to require restraint to manage their behaviors than were children who experienced the Wand. These investigators concluded that the Wand held considerable promise as a means of reducing the management difficulties with school-aged children, but they also specifically recommended the need to replicate these results with younger, potentially more difficult preschool-aged children.

The purpose of this investigation was to extend this recent line of research by exploring the efficacy of the Wand in reducing management difficulties with preschool-aged children.

Methods

Forty healthy pediatric patients between 2 and 5 years of age were used (mean=4.1). There were no gender, race, or ethnic restrictions used in the study. Most (78%) were males. Patients were selected based on their need for operative dentistry in the maxilla requiring local anesthesia. No effort was made to control for previous experience, but the presence of previous experience was noted for each patient. No patients were included in the study that had easily discernable limitations of mental status. The procedures, possible discomforts or risks, as well as the possible benefits, were explained fully to the parent or guardian and the subject. Their informed consent, as approved by the University's Institutional Review Board, was obtained prior to the investigation.

The local anesthetic was delivered using either the Wand¹⁹ or a traditional syringe. All injections consisted of 2% Xylocaine with 1:100,000 epinephrine. A 30-gauge needle was used with both methods of delivery. The Wand delivers anesthetic at two different rates controlled by a foot pedal. The maximum local anesthetic delivered by the

Wand using one cartridge is 1.4 cc. The average amount of local anesthetic administered using the Wand was 1.0 cc (range 0.7 cc to 1.3 cc) delivered via the palate to either anterior and middle superior nerve (AMSA) or the anterior superior alveolar nerve (P-ASA).¹⁸ While administering a traditional buccal infiltration, 1.0 cc was delivered. The traditional palatal injection required is 0.18 cc.

Pain behavior was measured using an established pain behavior code.^{20,21} Four pain behavior categories were used. (1) Body movements were defined as movement of any part of the body 15 cm or more. The criteria could be met as one single motion or a repetitive series of smaller, continuous motions. (2) Crying was defined as any crying, moaning, complaining or vocalization in general that was related to describing pain or discomfort. (3) Restraints were defined as any restraint by the dental assistant to control the patient's movements. Not included were reassuring touches by the dental assistant or hands placed lightly on the child in anticipation of possibly needing to restrain. (4) Stoppage of treatment was defined as any cessation of the dental procedure due to child movements that required the dentist to redirect the child, get the child under control, or prevent harm to the child. This behavior was coded for only two children, one each during the palatal and buccal injections. It was dropped from the analysis due to infrequent occurrence.

The observer began recording when the dentist was looking at and touching the child. The observer stopped recording when the dentist was either not looking at or not touching the child.

Subjects were selected from a continuous sample of patients of record and represented a cross section of children who presented at a university clinic at a large Midwestern urban setting. The child was randomly assigned to either the wand or the traditional injection technique for administration of the local anesthetic.

Topical anesthetic was placed in the area of the injection site for 30 seconds. Nitrous oxide was not used during any of the injections. The injection was then administered. For the Wand, a cotton tip applicator was pressed firmly to the tissue at the proposed injection site for 5 to 10 seconds. For the Wand P-ASA, the injection site was just lateral to the incisive papilla. For the Wand AMSA, the injection was administered half way between the mid-palatal raphe and the free gingival margin bisecting the first and second primary molars. The needle tip bevel was placed flat against the tissue. Administration of anesthetic at the slow rate began and, after 5 seconds, slight tissue penetration was established. The slow rate of delivery was continued once the needle penetrated the soft tissue to allow an anesthetic pathway to develop prior to further tissue penetration. Once the needle tip reached the level of the bony palate, the slow rate of administration was continued until slight blanching of surrounding tissue was visualized.

Table 1. Mean Percentages of 15-Second Intervals with Disruptive Behaviors, Wand vs traditional Injections

Injection condition	Mean duration	Any disruptive behavior	Crying	Body movement	Restraint
Wand	179	50%	30%	28%	3%
Traditional	54	71%	57%	49%	34%
<i>t</i> value	12.39‡	2.10*	2.40*	2.34*	3.44†

**P*<.05; †*P*<.01; ‡*P*<.001.

Buccal infiltration and palatal injection were administered for the traditional technique. A distraction technique in the form of a cheek wiggle was employed for the buccal infiltration upon insertion of the syringe. For the traditional palatal injection, pressure was applied using a cotton tip applicator, similar to that used with the Wand injection, before insertion of the syringe. Once anesthesia was achieved, dental treatment was delivered.

The tell-show-do technique was utilized for all patients; however, the subjects were visually shielded from knowing which local anesthesia technique he/she received. No subject was used twice for this study and the same operator delivered treatment throughout the study.

A research assistant observed all treatment sessions and coded occurrence of the target behaviors on a 15-second interval recording system. Sessions were also videotaped. A second independent observer separately coded 15% of the visits to assess the reliability of the observation coding system. Reliability was calculated by dividing agreements on occurrence of each behavior with agreements + disagreements. Reliability was found to be 82%. The research assistant also timed the duration of each injection while concurrently coding behavior.

Two different types of statistical analyses were conducted. First, an overall analysis was performed comparing the two treatment conditions on the percentage of 15-second intervals with each type of disruption, using *t* tests to compare their mean percentage of disrupted intervals. This provided an overall comparison on their levels of disruptive behavior between the Wand and traditional groups.

Second, an equivalent intervals analysis was conducted, comparing the two techniques during equivalent injection durations. This was done because a central purpose of the Wand is to reduce the pain of the injection by lengthening the duration of the injection and delivering anesthetic at a constant rate, pressure and volume. As a result, observed differences in disruptive behavior between the two procedures might be a function of real differences in pain or disruptive behavior might be a secondary reaction to differences in injection duration (eg, longer durations provide more time to calm down or more time to become impatient and disruptive). Thus, the equivalent intervals analyses were conducted to control for duration by comparing the percentage of children showing each type of disruption in equivalent intervals. These analyses compared the Wand with each of

the two traditional injections, using Fisher's exact test for contingency-table data. The analyses were limited to 15-second intervals that included at least 35% of the sample in each condition. The palatal injection had insufficient patients remaining after 30 seconds (ie, two 15-second intervals), and the buccal injection

had insufficient patients beyond 45 seconds (ie, three 15-second intervals). The first 15-second interval was emphasized because it represents the patients' initial reaction to the injection.

Results

The two groups were comparable in age, gender and previous experience with dental injections. The mean age for both Wand and traditional groups was 4.1 years with a range of 2 to 5 years. The Wand group included 85% boys, whereas the traditional group had 70% boys which was not a significant difference (Fisher's exact test). There were no significant differences (Fisher's exact test) between the numbers of children with previous experience in the Wand group (70% of the sample) and the number of children with previous experience in the traditional groups (65% of the sample). Thus, boys and girls and those with previous experience were randomly distributed between the two groups. Finally, as expected, the Wand injection took significantly longer (mean±SD=178.5+33.6 seconds) than either the palatal injection (14.5±15.2 seconds, *t* (26.6) =-19.92, *P*<.001) or the buccal injection (39.7±19.5 seconds, *t* (38) =-15.99, *P*<.001).

The results from the overall *t* test comparisons showed that children receiving the Wand injection exhibited disruptive behaviors in a smaller percentage of 15-second intervals than did those receiving the two traditional injections. Table 1 shows that Wand patients showed one or more disruptive behaviors in 50% of the intervals during their injection, whereas traditional patients showed disruptive behaviors in 71% of their injection intervals. A similar difference was found for each specific disruptive code. The biggest difference was found for restraints. Restraints were needed for a mean of only 3% of the intervals for Wand patients compared with 34% of the intervals for traditional patients.

The results from the equivalent intervals analyses showed that the initial reaction to the Wand injection involved fewer disruptive behaviors than was the case for either of the two traditional injections. As shown in Fig 1 and Table 2, only 25% of the Wand patients exhibited disruptive behavior during the initial 15-second interval, which was significantly fewer than the palatal injection (80%, *P*<.01) or the buccal injection (75%, *P*<.01). The cumulative percentage of wand patients with at least one disruptive behavior increased to 45% by 30 seconds, which was still significantly fewer than

during the palatal (90%, $P<.01$) or the buccal (80%, $P<.05$). By 45 seconds into the injections, 80% of patients had shown at least one disruptive behavior during both the Wand and buccal injections.

Similar patterns occurred for specific disruptive behaviors of crying, body movements, and restraints (Table 2). Fewer Wand patients cried during the first 15-second interval than did traditional patients during either the palatal ($P<.01$) or the buccal ($P<.05$). Fewer Wand patients had cried than had traditional palatal patients by the end of the second interval ($P<.05$), but the cumulative Wand vs buccal differences in crying became non-significant by the second and third intervals. Wand patients were significantly less likely to exhibit body movements than palatal patients during the first interval ($P<.01$), but there was never a significant difference in body movements between Wand and buccal patients.

No Wand patient needed restraint during the first 15-second interval, which was significantly fewer than the 45% that needed restraint that soon during the palatal ($P<.01$), but not significantly fewer than the 20% requiring restraint immediately during the buccal (See Fig 2). By 30 seconds, 10% of the Wand patients needed restraint, which was still significantly fewer than the 50% requiring restraint during the palatal injection ($P<.05$). Although the Wand took longer, only 20% of the Wand patients ever needed restraint, which was fewer than the 50% that needed restraint sometime during the two traditional injections, although this

difference was not significant ($P<.10$). Moreover, restraints tended to be briefer when the Wand was used. Thus the mean number of 15-second intervals with restraints was significantly fewer during the entire Wand injection (mean=0.30±0.73) than during the two traditional injections (1.15±1.69, $t(25.9)=2.06$, $P<.05$).

Discussion

The results of this investigation extend the results of the previous research on the Wand in several ways. First, consistent with previous research on school-aged children, the results show that, overall, using the Wand to deliver anesthetic leads to significantly fewer disruptive behaviors in preschool-aged children when compared with a traditional injection regimen. That is, children injected using the Wand-prescribed palatal injections required significantly less disruptive behavior and showed significantly less restraint than children injected with traditional buccal and palatal injections.

Second, even when controlling for duration of the injection, the computer-controlled, slow rate of anesthesia delivery does appear to reliably reduce pain-related behavior in young children. These young children were significantly less likely to cry or to move in a disruptive fashion. Perhaps most impressive were the results

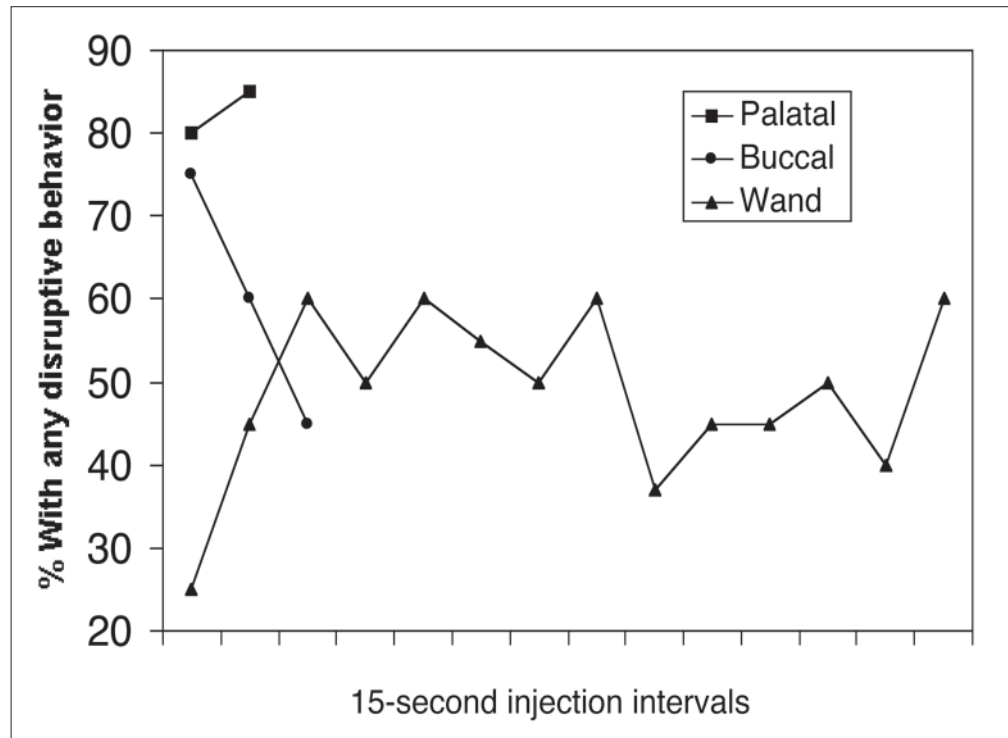


Fig 1. Percent of patients displaying any disruptive behavior during consecutive 15-second intervals for the Wand and each of the traditional injection conditions

Injection type	% of patients with any disruptive behavior, first 15 seconds	% of patients who cried, first 15 seconds	% of patients with body movements, first 15 seconds	% of patients requiring restraint, first 15 seconds
Wand	25	15	15	0
Traditional - palatal	80†	70*	60*	45†
Traditional - buccal	75†	55*	40	20

* $P<.05$, compared to Wand, Fisher's exact test for contingency tables; † $P<.01$, compared to Wand.

showing that none of the preschool-aged children exposed to the Wand required restraint during the initial interval, while nearly half of the children receiving a traditional injection required some type of immediate restraint.

As a whole, these results are important because they demonstrate that the Wand can significantly reduce disruptive behaviors in a population of young children who are traditionally more difficult to manage. Reducing disruptive behaviors in preschool-aged children is important not only because it creates a more positive experience for the child, but it also creates a more positive experience

for the practitioner. Increasing preschool-aged children's access to dental care may depend on both.

Beyond the first 15-second interval of the injection, it is interesting to note the gradual increase in milder disruptive behaviors by the children in the Wand group. This stands in particular contrast to the results of Gibson et al, where the disruptive behaviors for children in the Wand group diminished over time.¹⁷ While the increases noted in this study occurred in only about half of the patients in the Wand group and were not associated with any increase in the rate of restraint, these data do suggest that, at least for preschool children, the longer time required for the Wand injection may result in more restless behavior. The Wand required an injection time almost 4 times longer than the traditional injections, an insignificant difference for school-aged children but one that preschoolers may not tolerate as well. This might be considered a potential limitation of the Wand—a limitation that should be considered when doing a cost-benefit analysis of the Wand.

While it is important for all studies of injection pain to take direct measures of pain behavior such as child body movements and vocalizations, there are other important measures of pain and anxiety not included here. Unfortunately, preschool-aged children cannot be counted on to provide reliable and valid reports of their own pain and distress. However, measures of heart rate, blood pressure, respiration or galvanic skin response can provide indirect measures of pain and anxiety, and one or more of these measures would have strengthened the conclusions of this investigation. In addition, these measures are not subject to

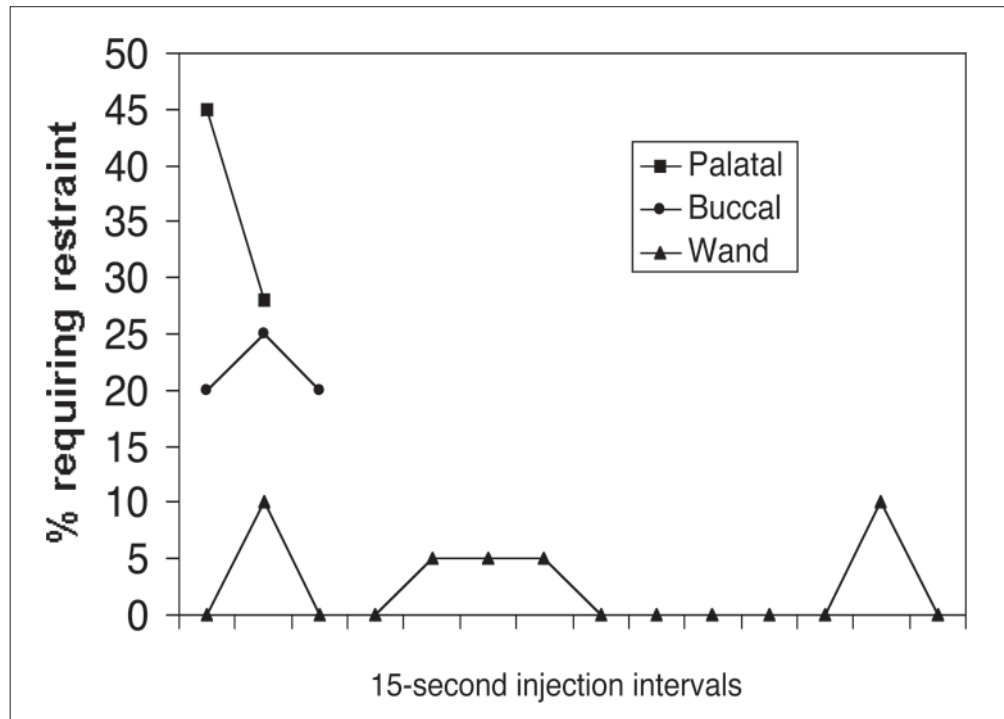


Fig 2. Percent of patients requiring restraint during consecutive 15-second intervals for the three injection procedures

observer bias and could provide important validation of direct observation measures.

Finally, while the Wand appears to provide complete pulpal/palatal anesthesia for the initial injection, it is unclear exactly how long this anesthesia lasts. Future research should explore the duration of profound anesthesia and whether a single injection is adequate for lengthier procedures such as a pulpotomy.

Conclusions

The Wand injection system appears to result in significantly less disruptive behavior and require significantly less restraint in young, preschool-aged children when compared with traditional injection procedures. The benefits are consistent, whether comparing the two injection procedures overall or just during the initial moments of each injection, controlling for differences in injection durations. However, young preschool-aged children may become restless with the lengthy injection duration required by the slow rate of delivery of anesthetic solution by the wand. The Wand appears to be one method of creating a more positive experience for the young child and possibly the practitioner.

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ABSTRACT OF THE SCIENTIFIC LITERATURE



TOOTH WEAR IN CHILDREN WITH DOWN SYNDROME

The purpose of this prospective study was to compare the etiology, severity and prevalence of tooth wear in children with Down syndrome to a healthy control group. Forty-nine children with Down syndrome were compared to a group of 49 control subjects. All subjects in both groups had an oral examination (including dental impressions) completed both a three-day dietary analysis and a questionnaire on oral habits, medical problems and current medications. The authors reported that children in the Down syndrome group had significantly more frequent and more severe wear than the control group. Also, although no dietary link was established, significantly more children in the Down syndrome group had a multifactorial etiology (involving both attrition and erosion) to their wear than the non-Down syndrome group.

Comments: The article makes clear the difficulty involved in trying to prevent tooth wear in children with Down syndrome. MM

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