Pain Perception: Computerized versus Traditional Local Anesthesia in Pediatric Patients

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***Background**: Local anesthetic injection is one of the most anxiety- provoking procedure for both children and adult patients in dentistry. A computerized system for slow delivery of local anesthetic has been developed as a possible solution to reduce the pain related to the local anesthetic injection. **Study design:** The present study was conducted to evaluate and compare pain perception rates in pediatric patients with computerized system and traditional methods, both objectively and subjectively. **Study design**: It was a randomized controlled study in one hundred children aged 8-12 years in healthy physical and mental state, assessed as being cooperative, requiring extraction of maxillary primary molars. Children were divided into two groups by random sampling - Group A received buccal and palatal infiltration injection using Wand, while Group B received buccal and palatal infiltration using traditional syringe. Visual Analog scale (VAS) was used for subjective evaluation of pain perception by patient. Sound, Eye, Motor (SEM) scale was used as an objective method where sound, eye and motor reactions of patient were observed and heart rate measurement using pulse oximeter was used as the physiological parameter for objective evaluation. **Results**: Patients experienced significantly less pain of injection with the computerized method during palatal infiltration, while less pain was not statistically significant during buccal infiltration. Heart rate increased during both buccal and palatal infiltration in traditional and computerized local anesthesia, but difference between traditional and computerized method was not statistically significant. **Conclusion**: It was concluded that pain perception was significantly more during traditional palatal infiltration injection as compared to computerized palatal infiltration, while there was no difference in pain perception during buccal infiltration in both the groups*

INTRODUCTION

Pain is a very subjective sensation encompassing level of anxiety, trust, personality and perceived control over the painful stimulus.[1] Many contextual, psychological, and physiological factors may moderate the relation between the pain stimulus and the pain response. In children, the level of maturation of physical, cognitive and emotional systems are also of influence.[2]

Local anesthetic injection is one of the most anxiety- provoking procedure for both children and adult patients in dentistry.[3] Thus, it is necessary to search for techniques that minimize/ reduce pain in patients in order for them to report greater satisfaction with treatment.[3] Methods used to reduce pain during local anesthesia include: (1) Application of topical anesthesia; (2) Use of narrow needles; and (3) Slow delivery of the injected solution.[4]

An innovative computerized system for slow delivery of local anesthetic, Wand, has been developed as a possible solution to reduce the pain during the local anesthetic injection.[4] The core technology is an automatic delivery of local anesthetic solution at a fixed pressure: volume ratio regardless of variations in tissue resistance. This results in a controlled, highly effective and comfortable injection even in resilient tissues such as the palate and periodontal ligament.[4,5] It is claimed that when advanced slowly, the drops of solution anesthetize the tissue ahead of the needle, thereby yielding a virtually painless needle insertion.[2] All techniques of local anesthesia such as maxillary and mandibular infiltration, mandibular block, intraligamentary can be performed with the Wand system.[4]

Though many studies have been conducted to assess the efficacy of this computerized anesthesia system[1,6,7,8,9,10], data in children is scarce. Most of the studies have evaluated pain response by subjective methods.[1,7,10,11] Present study was conducted to evaluate and compare pain perception rates in pediatric patients with computerized anesthesia and traditional methods, both objectively and subjectively.

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MATERIALS AND METHOD

One hundred children aged 8-12 years, who were undergoing dental treatment at Department of Pedodontics and Preventive Dentistry participated in the study. Children were in a healthy physical and mental state and were assessed as being cooperative, having behavioral ratings 'positive' or 'definitely positive' according to Frankl behavior classification scale. All the children had maxillary primary molars that required extraction. None of the patients was treated under conscious sedation or received any treatment that could modify their behavior or awareness of pain. The procedures, possible discomforts or risks were fully explained to the parent, and their informed consent was obtained. Ethical approval was obtained from Institutional Ethical Committee at ESIC Dental College, Delhi.

Children were divided into two groups- Group A received buccal and palatal infiltration using Wand (Single tooth anesthesia system, Milestone Scientific Inc.,USA), while Group B received buccal and palatal infiltration using traditional syringe. Both techniques used Lidocaine HCl 2% with 1: 80,000 epinephrine (Septodont, France) as the anesthetic solution with a one inch long 30gauge needle. A preoperative radiograph was taken prior to extraction. Each child was assigned to receive either conventional local anesthesia or computerized anesthesia by random sampling using chit method. All the injections were carried out by the same experienced and skilled pediatric dentist.

The tissues were dried with a gauze. The topical anesthetic (Lignox spray, Septodont, France) was applied and left in place for one minute. Total Local anesthetic in a cartridge is 1.8 ml. and we used $2/5^{th}$ of that amount i.e. 0.72ml for buccal infiltration and $1/5^{th}$ i.e. 0.36ml for palatal infiltration. Reason for selecting such an amount was that- there were five markings in display showing local anesthesia amount on the Wand machine and for convenience we used one part for palatal and two parts for buccal. It was observed that even if the display was showing empty cartridge, there was still around 0.36ml left in the cartridge, so per marking amount of local anesthesia was 0.36ml. The recommended dose for buccal infiltration is 0.6ml and for palatal is 0.2- 0.3ml.[12] Doses used by us were well below the maximum dose of local anesthetic which is 6.6mg/kg body weight.[12]

The computerized system injections were given according to the instructions of the manufacturer and only the slow speed mode was used. The traditional syringe injection was given according to the standard technique.

Prior to starting the dental treatment, the researcher explained the 10 point Visual Analog scale (VAS) to the patient, which was used for subjective evaluation. The VAS is a 100mm line anchored at each extreme from 'no pain' to 'pain as bad as it could be' and coloring graduated from blue to red. For objective evaluation, SEM scale and heart rate recording were used. In SEM scale sound, eye and motor pain reactions of patient are observed. The reactions are classified on a scale from 1-4 categories: comfort, mild discomfort, moderately painful, and painful for each of the S, E and M code (Table 1). The S, E and M values of a child are added to get SEM score for that child. The second researcher (first is the dentist giving local anesthesia) standing at a distance of 1.5 m from the dental chair, evaluated the patient's sounds, eye - signs and body movements during injection. Second researcher was an impartial observer, who was not part of the study. For calibration 15 children were observed by both the researchers and rated separately. Each disagreement was discussed until full agreement was reached. These patients were not included in the study. Intra-evaluate kappa values for second researcher were 0.7.

Heart rate, as a physiological indicator of pain response, was recorded using pulse oximeter (Schiller Ag, Switzerland). It was placed on the right index finger of the patient and heart rate recorded before and during buccal and palatal local anesthesia. For heart rate measurement, the subjects were connected to a pulse oximeter (Schiller Ag) by means of a sensor attached to the nail of the right index finger. No audible beeping noise was emitted by the pulse oximeter. Three readings were taken: Reading one was before injection which was the average of readings taken at 2 minute interval for 8 minutes prior to administration of anesthetic injection. Reading two was during buccal infiltration injection and was the average of readings taken at 15 seconds interval during injection administration. Reading three was during palatal infiltration injection and was the average of readings taken at 15 seconds interval during injection administration.

Immediately after injection, the patients were asked about the amount of pain they had perceived during the injection and asked to point and mark on VAS.

Parametric test was used to compare the two groups as data collected was in normal form (identified by plotting Q-Q plot),. Statistical analysis using t test was performed to compare the results. Level of significance chosen was $\alpha<0.05$.

RESULTS

The average age was 9.14 years old with a range of 8 to 13 years old. Out of a total of 100 children 46 were girls and 54 were boys.

According to VAS score, patients experienced significantly less pain of injection with the computerized as compared to traditional method during palatal infiltration ($p<0.05$). During buccal infiltration also there was less pain in computerized anesthesia, but difference was not statistically significant ($p>0.05$) (Table 2).

As per SEM score statistically significant less pain was experienced with computerized anesthesia as compared to traditional method during both buccal and palatal infiltration injection ($p<0.05$) (Table 2).

Heart rate increased during both buccal and palatal infiltration in traditional and computerized local anesthesia, but difference between traditional and computerized method was not statistically significant ($p>0.05$) (Table 2).

When comparison was made between females and males, females perceived slightly more pain as per VAS and SEM, but the difference was not statistically significant (Table 3).

Table 1: SEM Score

Score	Designation	Sounds	Eyes	Motor
0	Comfort	No sounds indicating pain	No eye signs of discomfort	Hands relaxed, no apparent body tenseness
1	Mild discomfort	Nonspecific possible pain indication	Eyes wide show of concern, no tears	Hands show some tension
2	Moderately painful	Specific verbal complaint	Watery eyes	Random movement of arms/ body grimace, twitch
3	Painful	Verbal complaint indicates intense pain	Crying, tears running down the face	Movement of hands to make aggressive physical contact, pulling head away punching

Table 2: Distribution of VAS scores, SEM Scores and Mean Heart Rate during buccal and palatal infiltration injection.

	Traditional	Buccal		Palatal	
		Computerized	Traditional	Computerized	
VAS Score	Minimum Score	0	0	1	0
	Maximum Value	3	4	7	6
	Mean Score ± SD	1.24 ± 0.74	1.16 ± 0.96	2.94 ± 1.35	2.38 ± 1.23
	p Value (Student t test)	0.64		0.03	
SEM Score	Minimum Score	0	0	0	0
	Maximum Value	4	3	6	5
	Mean Score ± Standard Deviation	1.64 ± 1.14	1.08 ± 0.94	3.16 ± 1.28	2.44 ± 1.31
	p Value (Student t test)	0.01		0.01	
Mean Heart Rate	Before Injection	83.52 ± 5.10	83.64 ± 4.54	83.52 ± 5.10	83.64 ± 4.54
	During Injection	99.3 ± 7.90	97.74 ± 9.15	102.26 ± 7.61	102.46 ± 9.38
	p Value (Student t test)	0.36		0.91	

Table 3: Comparison of VAS, SEM and Heart Rate in males and females in traditional anaesthesia and computerized anaesthesia

Variables	Traditional Anaesthesia			Computerized Anaesthesia		
	Male, n=30	Female, n=20	p-value	Male, n=24	Female, n=26	p-value
	Mean ± Std. deviation	Mean ± Std. deviation		Mean ± Std. deviation	Mean ± Std. deviation	
VAS Buccal	1.10 ± 0.84	1.45 ± 0.51	0.10	1.13 ± 0.99	1.19 ± 0.94	0.81
VAS Palatal	2.83 ± 1.37	3.10 ± 1.33	0.50	2.38 ± 1.31	2.38 ± 1.17	0.98
SEM Buccal	1.33 ± 1.21	2.10 ± 0.85	0.018	1.21 ± 1.02	0.96 ± 0.87	0.36
SEM Palatal	2.93 ± 1.51	3.50 ± 0.76	0.13	2.29 ± 1.52	2.58 ± 1.10	0.45
HR Before Injection	84.43 ± 5.07	82.15 ± 4.96	0.12	83.21 ± 5.25	84.04 ± 3.83	0.52
HR during buccal	100.10 ± 8.00	98.10 ± 7.79	0.39	96.92 ± 9.52	98.50 ± 8.91	0.55
HR during palatal	102.93 ± 7.66	101.25 ± 7.63	0.45	102.79 ± 9.90	102.15 ± 9.06	0.81

DISCUSSION

The aim of this clinical study was to compare a computerized device (the Wand) with a traditional syringe in terms of pain of needle insertion and injection during buccal and palatal infiltration injection in maxillary molars.

Injection is an anxiety provoking stimulus especially among children and it is difficult to distinguish anxiety from pain physiologically.[13] Very anxious children report more pain and display more pain associated behavior and distress related to local anesthesia injection.[14] For this reason, only children who were cooperative, having 'positive' or 'definitely positive' behavioral ratings according to Frankl scale[15] were included in this study.

Extraction procedure was selected as this procedure is considered to be the most painful procedure for children.[16] Because of the characteristic of the palatal tissue the palatal injection was deemed to be among the most painful of dental injections, and indeed is considered by many dentists to be one of the most traumatic techniques used in dentistry.[6,7] Thus maxillary molars extraction procedure was selected requiring both buccal and palatal infiltration injection.

Visual Analog Scale was used for subjective evaluation. VAS is considered to be a valid and reliable ratio scale for measurement of pain.[1,3] The VAS is comprehensible and reliable for 8 years and older children[3], hence children above 8 years were included. SEM scale introduced by Wright is an objective method that observes sounds, eye and motor reactions and has been used in previous studies to measure comfort or pain in children.[13,16,17] Heart rate measurement was the physiological parameter used for objective pain evaluation. This measurement can provide indirect measures of pain and anxiety.[3] This measurement is not subject to observer bias and can provide important validation to direct observation measures.[18]

While analyzing the overall VAS score, SEM scale and mean heart rate, it was observed that pain was significantly more during traditional palatal infiltration injection as compared to computerized palatal infiltration. During buccal infiltration, pain was also less in computerized anesthesia, but the difference was not statistically significant with respect to VAS and heart rate, whereas this difference was statistically significant on SEM scale. Recording of heart rate was done as follows: HR recorded before injection, then buccal injection given and HR recorded during that period, then palatal injection given and heart rate recorded during that injection. What we feel is that because of fear of injection, heart rate increased during both the injections.[16] Though it increased from buccal to palatal injection also (may be because child felt more pain in palatal injection), the difference was not statistically significant.

Every child has different pain thresholds and thus physical reactions to a stimulus may vary from child to child. Thus one scale cannot be considered sufficient for pain evaluation. For better outcome of study we used three scales namely- VAS, SEM and heart rate measurement.[3]

These findings are in agreement with Gibson *et al*[19], Ashkenazi *et al*[5], Allen *et al*[18]. Gibson *et al*[19] reported that during palatal injection, Wand patients were significantly less likely to cry, to exhibit disruptive body movements, and to require physical restraint.

In contrast there were no significant differences in disruptive behavior when comparing Wand with the traditional buccal injection. Ashkenazi *et al*[5] stated that computerized device caused low levels of stress and pain- disruptive behavior reaction after palatal infiltration that was equal to that for buccal infiltration. Allen *et al* [18] administered buccal infiltration and palatal injection with the traditional technique, while a palatal approach to the anterior and middle superior alveolar nerves and the anterior superior alveolar nerve was used with the Wand injection and found that Wand could significantly reduce disruptive behaviors in children. His study was in young age group- 2-5 years.

Similarly Ran and Peretz[20] showed that children displayed better behavior when they received local anesthesia with the Wand than with the conventional infiltration, however they used different injections i.e. periodontal ligament injection was given with Wand, while infiltration injection was given with conventional method. Versloot *et al* [21] found that low anxious children receiving local anesthesia with Wand displayed less muscle tension, less verbal protest and less movement than children receiving local anesthesia with traditional syringe. Within the high anxious group no differences were found. However in this study injection site was not taken as a variable.

Comparing studies for buccal infiltration injection only, results similar to our study have been reported by Ram and Peretz[22] and Nicholson *et al* [9]. They reported during maxillary infiltration injection lower discomfort with Wand than with the traditional syringe but it was not statistically significant.

Other studies [7,10,11,23] compared only palatal injection with Wand and traditional method. All reported lower pain levels during anesthetic delivery with Wand as compared to conventional technique in adults. Also it was reported that pain was less in Wand, but it did not become zero. No difference in heart rates could be seen in slow and fast flow rates, though lesser pain was seen in slow rate.[23]

There are authors reporting no clear difference between Wand and traditional methods[2,24] also. In Versloot [2] study there was no standardization with regard to type of dental treatment, injection site or administered volume and the children were referred children to a specialized dental care. In Tahmassebi [24] study age range was very wide, from 3 years 3 months to 10 years and only VAS scale was used.

However, Lopez *et al* [3] showed that traditional syringe injections were more painful than computerized injection device during both vestibular and palatal infiltration injections. Less pain during both injections in computerized technique could be due to the fact that each subject was its own control while in our study subjects were different in each method of anesthesia.

The reason for more pain during palatal injection with traditional syringe could be because that with traditional injection operator intermittingly increases thumb pressure on the plunger of the syringe. Subsequently, as the solution is injected into the tightly bound tissue of the palate, the pressure is elevated and pain results. Because the computer assisted injection controls the rate of anesthetic solution deposition, it resulted in less pain.[10] Lee *et al* [6] speculated that a controlled delivery of anesthetic solution with the computer assisted injection system perhaps created an improved pressure gradient environment for the diffusion of solution through the palatine process. Hochman *et al*[11] stated that Wand can maintain an optimal flow rate of local anesthesia even when different tissue resistances are encountered. The pressure produced during the injection can vary in order to maintain the desired flow rate, while the conventional syringe system directly links flow rate to the pressure at which the local anesthetic is injected. It is also not possible to maintain a particular flow rate when different resistances are encountered

during manual administration.

No significant difference in pain perception was found between boys and girls receiving traditional injection as compared with the Wand. Similar results have been reported by Ran and Peretz.[20] In contrast Versloot *et al* [2] reported that Wand system reduces internalizing behavior (such as muscle tension) in girls and externalizing behavior (such as verbal protest and body movement) in boys. But children in his study were all referred children, most of the referral was because of behavior management problems, while in our study all children were cooperative with Frankl rating of 'cooperative' or 'definitely cooperative'.

CONCLUSIONS

Based on this study's results, the following conclusions can be drawn:-

1. The computerized system of anesthesia seemed to provide less painful palatal infiltration injection as compared to traditional syringe in pediatric patients.
2. There was no difference in pain perception during buccal infiltration between computerized and traditional anesthesia.
3. Gender had no effect on pain perception.

Palatal injections are one of the most painful injections in dentistry. Wand can be used for these injections, especially in children to gain cooperation during treatment.

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