



Comparison of anxiety and pain perceived with conventional and computerized local anesthesia delivery systems for different stages of anesthesia delivery in maxillary and mandibular nerve blocks

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Background: Fear of local anesthesia (LA) is a significant impediment to dental care as many patients delay or avoid treatment to avert pain. Computer-controlled local anesthetic delivery system (CCLAD), with constant and controlled rate of flow, present a painless alternative. The present study aimed to compare anxiety and pain perceived with conventional and computerized systems, for different stages of anesthesia delivery when administering various nerve blocks.

Methods: One hundred patients requiring bilateral LA participated in the study. One side was anesthetized using one system and the contralateral side was anesthetized using the other, in two separate appointments. Patients assigned anxiety scores on a 5-point scale and used the visual analogue scale (VAS) for pain determination at needle insertion, during delivery of anesthetic solution, immediately after injection, and at the end of the periodontal procedure. Each patient's preference for the delivery system of future injections was also recorded.

Results: Patients reported significantly lower anxiety levels with CCLAD compared to the syringe. Significantly lower mean VAS scores for anesthesia deposition, pain immediately after, and at the end of the periodontal procedure were also noted. However, pain at needle insertion was comparable between the two systems, with no statistical significance. Overall, 64.4% patients preferred CCLAD for future anesthesia.

Conclusion: Lower pain perceived with CCLAD and higher preference for the system suggest that CCLAD should replace conventional syringes to allow pain-free dental treatment.

Keywords: Computer-controlled Local Anesthetic Delivery System ; Local Anesthesia; Pain; Pain Perception; Visual Analogue Scale.



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INTRODUCTION

The fear of local anesthesia (LA) is a significant impediment to dental care, as many patients delay or avoid treatment to avert pain. Nearly 20-23% of population is highly anxious about their dental treatment [1]. Pain can result from the mechanical trauma of needle insertion, or from the sudden distension of the tissues caused by rapid deposition of LA from the syringe [2].

Using a conventional hypodermic syringe, the dentist must simultaneously control the movement of the penetrating needle and drug infusion variables. The inability to precisely control both activities can compromise the injection technique, leading to painful insertion or inadequate deposition. Moreover, the conventional syringe is held with a palm-thumb grasp, which is not ergonomic.

The first computer-controlled local anesthetic delivery system (CCLAD) was introduced in 1997 as the Wand

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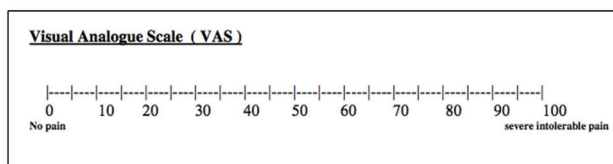


Fig. 1. The visual analogue scale (VAS) used for evaluating the perceived pain among patients.

(Milestone Scientific Inc., Livingston, USA) to improve the ergonomics and precision of dental syringe. Its lightweight handpiece can be held with a pen-like grasp, which provides better tactile sensation. The operator can accurately manipulate needle placement with fingertip accuracy and deliver the solution with a foot-activated control. The flow rate is computer-controlled and remains constant. Continuous positive pressure delivers an anesthetic drip that precedes the needle and provides a painless path for needle insertion [3]. The disadvantages associated with the system include high cost, complexity, space needed to store equipment, and increased time for LA administration [4,5].

Research on CCLAD is largely limited to pediatric patients. There is paucity of literature on its use in other fields of dentistry. The present study was undertaken to evaluate pain and anxiety associated with conventional syringe and CCLAD for nerve block LA, administered for periodontal procedures. In particular, this study compared pain associated with the two techniques during different phases of local anesthetic delivery (at needle insertion, during deposition of anesthesia, immediately after deposition, and at the end of the periodontal procedure).

METHODS

This is a prospective randomized split-mouth study. Patients aged 18-65 years with periodontal disease, requiring bilateral LA in the same arch, were recruited for the study. Patients who are allergic to LA or any of its components, medically compromised, smoking, pregnant, lactating, or taking corticosteroids or non-

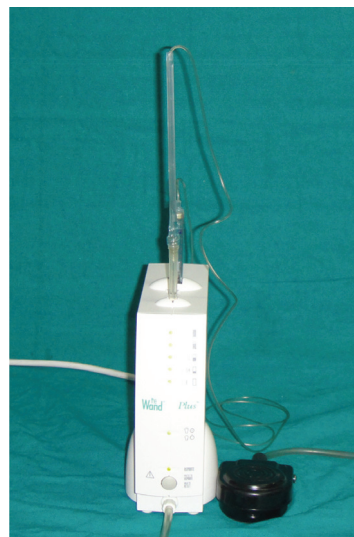


Fig. 2. The computer controlled local anesthetic delivery system.

steroidal anti-inflammatory drugs were not included. Written informed consent was obtained from participants, in accordance with the Committee on Human Research Guidelines, University of Delhi. The Institutional Review Board number for the study was Maids/Perio/01/2011.

Anesthetic Injection Procedure: On the first appointment for periodontal therapy, the patient underwent a sensitivity test for LA and was familiarized with the scales used for evaluating anxiety and pain. Anxiety was determined immediately prior to LA administration on a 5-point scale as follows: 0-no anxiety, 1-mild anxiety, 2-moderate anxiety, 3- severe anxiety and 4- extreme anxiety or panic [6]. The visual analogue scale (VAS) was used for the evaluation of pain [7]. VAS was scored on a 100-mm horizontal line with the left end marked “no pain” and the right end “severe intolerable pain” (Fig. 1).

In each case of CCLAD, 2% lidocaine anesthetic solution with 1:80,000 adrenaline (Lignospan Special™, Septodont, India) was used with a 30-gauge 1.25-inch needle (Fig. 2). A disposable 30-gauge 1.25-inch needle (Septoject, Septodont, France) was used for conventional LA delivery via a dental syringe.

Types of injections used for the mandibular arch were the inferior alveolar (IAN), long buccal (LB), and mental (MN) nerve blocks. Types of injections used for the

Table 1. Types and numbers of injections administered

Type of injection	Number
Infraorbital nerve block	24
Posterior superior alveolar	28
Inferior Alveolar Nerve block	24
Greater palatine nerve block	20
Anterior Middle Superior Alveolar block	13
Mental nerve block	16
Long buccal nerve block	10
Total	135

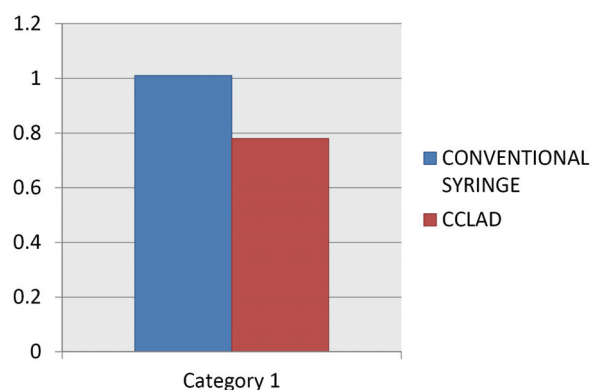
Table 2. Types of periodontal procedures performed after administration of local anesthesia

Type of Periodontal therapy	Number
Curettage	44
Flap surgery	26
Subgingival scaling	24
Gingivectomy	03
Implant surgery	01
Depigmentation	01
Abscess Drainage	01
Total	100

maxillary arch were the posterior superior alveolar (PSA), infraorbital (IO), greater palatine (GP), and anterior middle superior alveolar (AMSA) nerve blocks. The volume of anesthetic solution injected was in accordance with the procedure recommended by Malamed [8].

At the first appointment, anxiety was determined prior to the injection. CCLAD or conventional syringe was randomly selected and used to deliver LA to one side of the arch. The patient was asked to rate the associated pain on VAS at the following stages: during needle insertion, during delivery of anesthetic solution, and immediately after the injection. Pain was also assessed at the completion of the periodontal procedure. Similarly, at the second appointment, the contralateral side of the arch was anesthetized for treatment using the other anesthetic delivery system. Anxiety and pain were recorded as above. The delivery system preferred by the patient for future injection delivery was noted.

The data were analyzed using SPSS software version 17.0. Mann-Whitney U tests were used to compare the anxiety and VAS scores obtained from the patients. The significance level was set as 5%.

**Fig. 3.** Comparison of mean anxiety scores between the computer controlled local anesthesia delivery system and conventional syringe.

RESULTS

One hundred adults (44 males and 56 females) with a mean age of 34.15 ± 18.92 years were selected from the Outpatient Department of Periodontology, Maulana Azad Institute of Dental Sciences according to the inclusion and exclusion criteria and enrolled in the study. In total, 270 injections (135 on each side) were administered. Table 1 provides data on the numbers of each type of injection. Periodontal procedures undertaken included subgingival scaling, curettage, gingivectomy and flap surgeries (Table 2).

The mean anxiety scores with conventional syringe and CCLAD were 1.01 ± 1.02 and 0.78 ± 0.91 , respectively, indicating a significantly lower anxiety level in the CCLAD group ($P = 0.043$) (Fig. 3).

For pain during needle insertion, the score for conventional syringe was 16.67 ± 15.24 . The mean pain score for CCLAD was 13.53 ± 13.05 , but the difference was not statistically significant. However, a significantly lower score for CCLAD was obtained, during drug deposition. The VAS scores were 14.51 ± 15.40 and 11.24 ± 14.25 for conventional and CCLAD techniques, respectively. The pain scores for immediately after the injection were similar, with a significantly lower mean pain score for CCLAD (3.86 ± 8.86) than conventional syringe (6.23 ± 9.40). Lastly, pain reported at the

Table 3. Descriptive data of mean visual analogue scale scores

Stage of administration	Conventional syringe	CCLAD* (WAND)	Difference	P value
Pain during needle insertion	16.67 ± 15.24	13.53 ± 13.05	3.14	0.076
Pain during drug deposition	14.51 ± 15.40	11.24 ± 14.25	3.27	0.053
Pain immediately after injection	6.23 ± 9.40	3.86 ± 8.86	2.37	0.000
Pain at completion of periodontal procedure	1.78 ± 4.51	0.96 ± 4.71	0.82	0.011

*: CCLAD: Computer Controlled Local Anesthetic Delivery System

completion of periodontal procedures was also lower in CCLAD, and this difference was statistically significant (1.78 ± 4.51 with conventional syringe; 0.96 ± 4.71 with CCLAD; $P = 0.011$) (Table 3).

In total, 64.4% of patients preferred CCLAD and opted for the same for any future injections; while 32.5% preferred conventional syringes. Additionally, 2.9% patients did not find any difference in the two delivery systems.

DISCUSSION

Local anesthesia is the backbone of pain control in dentistry. Its proper administration is the dentist's greatest aid in treating patients comfortably and in achieving cooperation. However, administration of LA injection produces anxiety and pain in patients. Therefore, research has continued to develop new and better ways of delivering adequate LA to improve patient comfort. CCLAD was developed with this same aim. The manufacturers hoped to minimize pain by delivering a controlled volume of solution at constant pressure irrespective of tissue resistance with a pre-puncture technique and use of careful axial needle rotation [3]. The present study aimed to evaluate anxiety and pain perceived with CCLAD, and to compare it with the conventional method of LA administration.

Anxiety level was significantly less when local anesthetics was administered using CCLAD compared to conventional syringes. The lower anxiety levels can be attributed to the less frightening appearance of the device. The loading of cartridge in CCLAD does not provoke

fear in patients as it does in the conventional syringes. Technological advances have led to great dependency and trust on machines. It could be that patients were less anxious and more accepting knowing an advanced, computerized machine was being used to achieve anesthesia. Krochak and Friedman [6] reported a similar observation in their patients who were successfully desensitized against dental injections anxiety, using the Wand. In contrast, Goodell et al. [9] observed less anxiety with the syringe than CCLAD. The authors speculated that the new and unfamiliar anesthesia device was perhaps more fear provoking [9]. In another study, Tahmassebi et al. [10] reported no statistical difference in anxiety when comparing the two systems. This may be attributed the study being conducted among children, who cannot accurately and with absolutely determine anxiety levels.

The mean VAS score for needle insertion was lower in CCLAD, but the difference was not statistically significant. In previous studies, Yenisy [11] and Yesilyurt [12] reported lower pain with CCLAD. Conversely, Nusstein [13] reported similar pain on needle insertion in both the systems when administered to anesthetize the anterior middle superior alveolar nerve. It has been speculated the computer-assisted injection systems create a continuous positive pressure that delivers anesthetic solution preceding the needle path, to eliminate discomfort as the needle penetrates the tissue. This pre-puncture technique could be the reason for lower pain perceived with CCLAD. However, in the present study, a significant difference was not obtained. It may be speculated that the lack of difference may be associated with same-sized needles being used in both systems.

Pain on LA deposition was significantly lower with



Fig. 4. Pen-grasp used in the computer controlled local anesthesia delivery system.

CCLAD. This is consistent with the findings of the studies by Yenisy [11] and Nusstein [13]. Lower pain may be attributed to the delivery of anesthetic solution at constant pressure, which is rapidly absorbed by surrounding tissues. A steady flow of 1 drop of anesthetic every two seconds is maintained by the stepper motor in the driver unit of CCLAD irrespective of the density of tissues. In contrast, in the conventional syringe, manual control does not allow consistent flow. The resistance encountered when injecting into dense connective tissue causes the operator to increase force on the syringe plunger, thus increasing the anesthetic volume that distends the tissues, thereby resulting in pain.

VAS scores for pain at the end of the periodontal procedure also showed significantly lower pain with CCLAD. This is in agreement with the findings of studies by Asarch et al. [14], Gibson et al. [15], Allen et al. [16], Fukayama et al. [17] and Palm et al. [18]. Reduced pain may be attributed to a more accurate technique and greater precision in the delivery of local anesthesia using CCLAD [19]. It allows a pen-grasp that is easier to manipulate and has a small headpiece for increased visibility of the target site, which enables precise delivery of the LA solution (Fig. 4). Additionally, CCLAD allows easier aspiration during injection without a change in the needle position; a problem frequently encountered with conventional syringes.

A higher patient preference for the less painful CCLAD was obtained in the present study. Nicholson et al. [20] also reported high acceptance of CCLAD amongst both

dentists and patients.

Most of the studies on CCLAD have been conducted among children. CCLA has been shown to decrease disruptive behavior. However, in order to obtain more reliable results and more accurate evaluation, the present study selected adults as participants. In particular, this study assessed pain at different stages of anesthetic administration, whereas most studies in the literature evaluated the experience overall and generally assessed pain at the end of a procedure [16,17,20,21].

VAS was used to determine the perceived pain at different stages of LA administration. Numerous methodologies exist to assess pain. It is well recognized that it is extremely difficult to quantify pain owing to its subjective nature. VAS provides the advantage of unlimited number of possible responses along with a simple continuum [22].

One limitation of this study was the inability to implement a double-blinded research design. Blinding is not possible, because the operator would always be aware of the significant difference between the two injection systems during LA administration. In addition, the patient would be able to hear the built-in beeping sound of the CCLAD, even if their vision was restricted.

In conclusion, the results of the present study demonstrated the advantages of CCLAD over the conventional syringe for delivering LA, as evidenced by the significantly lower anxiety and perceived pain among patients, as well as higher preference for CCLAD. Further studies using objective physiological markers of pain, such as changes in heart rate and blood pressure, may be useful for confirming the findings of this study.

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