A COMPARATIVE EVALUATION OF COMPUTER CONTROLLED LOCAL ANESTHESTIC DRUG DELIVERY DEVICE VS. CONVENTIONAL LOCAL ANESTHESIA IN MINOR ORAL SURGICAL PROCEDURE

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ABSTRACT

Aim and Objectives-The primary aim of this study was to evaluate the efficacy of Conventional local anesthesia delivery system and computer controlled local anesthetic drug delivery system. Specific objectives included assessing pain levels, onset of anesthesia, patient comfort, and anxiety levels, as well as monitoring hemodynamic changes (Blood Pressure and SpO_2) during and after deposition of local anesthesia.

Material and Methods- In this study 50 patients were divided into 2 equal group. Group A received local anesthesia via CCLAD system, while Group B received local anesthesia from traditional manual syringe.

Results- The intergroup comparison of comfort levels between the Study and Control groups showed a statistically significant difference (χ^2 = 15.263, p = 0.003). In the Study Group, 24% of subjects were very comfortable and 36% were comfortable, while 40% reported only mild discomfort. No participant in the Study Group reported uncomfortable or extremely uncomfortable levels. In contrast, the Control Group had fewer comfortable participants, with only 12% very comfortable and 28% comfortable. A greater proportion of the Control Group experienced discomfort, with 32% uncomfortable and 20% extremely uncomfortable. Overall, the Study Group demonstrated better intraoperative comfort compared to the Control Group.

Conclusion- While CCLAD system is superior to traditional syringes in terms of physiological comfort, pain and anesthetic efficiency, its phycological deterrent. The study concludes that CCLAD is a highly effective tool for pain free dentistry, but further refinement in the ergonomics and size of hardware is necessary to mitigate patient anxiety.

Keywords- CCLAD, Dental Fear, Dental Anxiety, Local Anesthesia

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INTRODUCTION

In dentistry, anxiety is strongly associated with unpleasant stimuli and can exacerbate pain perception through increased alertness, tense muscles, and pessimistic treatment-related thoughts. Dental needle phobia, being reclined and experiencing a loss of control in the chair, loud noises and vibrations from rotating equipment, intraoperative discomfort, and the unique tastes and smells of dental materials or medications are some of the main causes of anxiety.[1] Those who are afraid of dental operations typically avoid going to the dentist. It is crucial to remember that not everyone agrees with it, and some professionals contend that it oversimplifies the complicated nature of dental anxiety. Dental pain and poor oral health may rise from this avoidance. As a result, future dental visits may need more intrusive procedure, which may increase their anxiety. [2] To prevent pain during procedure like drilling, extractions and periodontal therapy, numerous methods, including intraligamentary injection, nerve block, and local infiltration, can be used to deliver local anesthesia.[3] The physical characteristics of the anesthetic solution, such as its temperature and pH, needle insertion trauma, and pressure from solution

injection are some of the reasons why local anesthesia can cause discomfort. Smaller-gauge needles, topical anaesthetics, and laser therapy at the injection site are some of the methods that have been suggested to lessen pain during local anesthetic injections. However, it seems that the best way to reduce pain during the administration of local anaesthetics is to slow down the injection speed.[4] Techniques like using small needles, pre warming local anesthetic solutions to body temperature, and varying injection rate show a dedication to increase patient comfort, encouraging routine dental appointments and eventually elevating the standard of oral care. [5] Although it is well known that a slow injection of local anesthetics is less painful than a rapid one, this is very challenging to accomplish with a traditional syringe because injecting the anesthetics with a palm-thumb grasp requires more force, and the pressure must be adjusted based on the density of the tissues. Therefore, it is nearly hard to administer the anesthetics using a traditional syringe at a steady, moderate flow rate. [6]

In mid-1990s start of the progress of local anesthetic delivery devices that is used for modulating the flow of anesthetic solution through a syringe using computer technology was seen. CCLAD, or computer-controlled local anesthetic delivery, is novel idea. First CCLAD device was the WandTM (Milestone Scientific, Inc., Livingston, NJ), which was introduced in 1997. Wand P1us and C0mpuDent, the current brand names, were subsequent revisions of the same manufacturer. Wand Plus was replaced in 2001 by the Comfort Control Syringe (Dentsply International, York, PA, USA). Anaeject (Nippon Shika Yakuhin, Shimonoseki, Japan) and 0ra Star (Showa Uyakuhin Kako, Tokyo, Japan) syringes, as well as QuickSleeper and Sleeper0ne devices (Dental Hi-Tec, Cholet, France), will be comparable products. Through regulated anesthetic injections, these electronic injection devices offer painless anesthesia at various speeds that can be changed.[6]

AIM AND OBJECTIVES

Aim: This comparative study was done to evaluate and compare the discomfort felt by the patient undergoing administration of injection Local Anesthesia using conventional syringe and Computer Controlled Local Anesthetic Drug Delivery System.

Objectives of the study were to evaluate

Subjective signs

1. Pain (Visual Analogue Scale)
2. Anxiety (Faces Anxiety Scale and Questionnaire)
3. Comfort (Comfort level rating scale)
4. Onset of anesthesia
5. Dental Concern Assessment

Objective sign

1. Blood Pressure – Digital Sphygmomanometer
2. Oxygen Saturation – Pulse Oximeter

MATERIALS AND METHODS

INCLUSION CRITERIA:

1. All healthy patients according to ASA-I and ASA-II criteria was selected.
2. Patients who belong to age group above 18 years was included.
3. Patients, who are co-operative, motivated were included.
4. Patients willing to participate in the study.

EXCLUSION CRITERIA:

1. Patients with uncontrolled systemic diseases and immune-compromised.
2. Patients with bleeding disorder.
3. Patients who fail to give proper consent.
4. Patients who are poorly motivated.
5. Pregnant (1st and 3rd trimester) and lactating patient.

Fig 1- Computer Controlled Local Anesthetic Drug Delivery

METHODOLOGY

Patients were split up at random into two groups. Group A (25 patients) on the study group in this Local Anesthesia will be injected by Computer Controlled Local Anesthetic Delivery System (needle of 30-gauge 25 mm in length). Group B (25 patients) i.e. the control group in this Local Anesthesia was injected traditionally by manual syringe (needle of 30-gauge 25 mm in length). Both the groups were administered 2% Lignocaine HCl with 1:80000 adrenaline.

RESULTS AND OBSERVATIONS

VAS score among study subjects- Participants in the Study Group experienced significantly lower pain perception compared to those in the Control Group. (Graph 1)

Anxiety score among study subjects- Participants in the Study Group experienced significantly higher

anxiety levels compared to those in the Control Group. (Graph 2)

Onset of anesthesia among study subjects- The Study Group achieved anesthesia significantly faster in comparision to the Control Group. (Graph 3)

Intergroup comparison of spo2 levels at different time intervals- Overall, oxygen saturation levels remained stable and comparable between both groups at all time intervals, indicating no significant intergroup variation in SpO_2 levels during the study period.

Intragroup comparison of SpO_2 levels at different time intervals- Overall, SpO_2 levels remained consistent and within normal physiological limits in both groups across all time intervals, demonstrating no significant intragroup variation. (Graph 4)

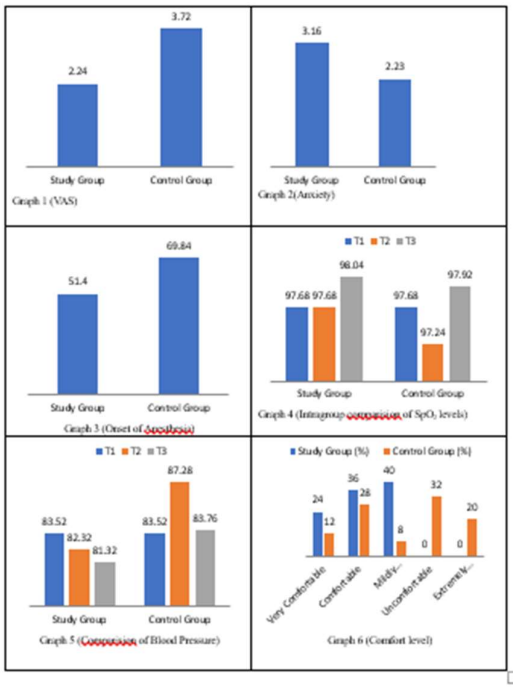
Intergroup comparison of systolic blood pressure levels at different time intervals- Overall, while baseline systolic blood pressure levels were comparable between the groups, significantly higher systolic blood pressure values were observed in the Control Group during and after the procedure.

Intragroup comparison of systolic blood pressure- Overall, significant intragroup variation in systolic blood pressure was observed only in the Control Group.

Intergroup comparison of diastolic blood pressure levels at different time intervals- Overall, while baseline diastolic blood pressure levels were similar between the two groups, the Control Group demonstrated significantly higher diastolic blood pressure values during and after the procedure.

Intragroup comparison of diastolic blood pressure- Overall, significant intragroup variation in diastolic blood pressure was observed only in the Control Group, while the Study Group maintained relatively stable values throughout. (Graph 5)

Intergroup comparison of comfort levels between groups- Overall, the distribution of comfort levels significantly favoured the Study Group, indicating better patient comfort compared to the Control Group. (Graph 6)



DISCUSSION

This study was conducted at Outpatient Department of Oral and maxillofacial Surgery department, in Teerthanker Mahaveer Dental College Hospital and Research Center "To assess the effectiveness of conventional local anesthesia delivery system vs. Computer controlled local anesthetic drug delivery system and quality of life in minor oral surgical procedure". Total of 50 patients were enrolled in the study and randomly assigned to either Group A and Group B. Group A (Study group) received 1ocal Anesthesia using C0mputer Contro1led Local Anesthetic drug de1ivery system, while Group B (Control group) received Local Anesthesia using Conventional syringe. The following discussion evaluates the outcomes observed in Group A and Group B.

A comparable age and gender distribution upon investigation the Study Group and Control Group were shown in this study, suggesting that baseline matching was successful for both the groups.[7] There was no significant effect on measured parameters due to age or gender which was also significant in finding of Ozge Anil et al [8], because any detected variations in primary and secondary outcomes can be more reliably attributed to the intervention rather than demographic factors, the successful age matching process enhances the study's internal validity [9].

In this study, when comparison of Control Group and the Study Group showed noticeably less pain in Study group, indicating either better anesthetic efficacy or a better delivery system in the experimental arm, which was similar to the study conducted by Eun-Jung Kwak et al [1], Ozge Anil et

al [1], Katarzyna Janik et al [2], Andrea Prol Castelo [10], Maryam Altuhafy[11], C.M. Jones [12], Mahmut Sumer [13], Murat Yenisey [14], Meet Shah [15], Yogesh Kumar Thoppe Dhamodharan [16], Yogesh Kumar T. et al [17], Kamal Aggarwal et al [18], Kunal Gajendragadkar [19], Sohar Flisfisch [20] and Rodaina H. Helmy [21] . However, in study of Sixou et al [1], In the context of administering local anesthesia, when discomfort during injection is a crucial patient experience outcome, this finding is especially significant [22].

The finding in Study group had higher levels of anxiety that the control group which was one of the study's key findings which was similar to Eun-Jung Kwak et al [8], C.M Jones et al [12], Mahmut Sumer et al[23] and Goodell et al [18] but conversely anxiety is reduced in studies conducted by Maryam Altuhafy[11], Meet Shah et al [15], and according to Tahmassebi et al [18] reported no statistical difference in anxiety. Increase in anxiety in study group can be due to large size of armamentarium and prolonged time of local anesthesia deposition. To properly characterize the anxiety response trajectory, future research should be effective.

There was no discernible intergroup fluctuation over the study period, since oxygen saturation (SpO_2) levels stayed constant and comparable between the two groups at all time intervals which was similar to studies of Eun-Jung Kwak et al [8]. From patient safety view this finding is comforting because maintaining appropriate oxygenation is crucial necessity throughout the administration of local anesthetic procedural sedation [24].

Although the Study Group and Control Group had similar baseline systolic blood pressure readings, the Study Group the systolic blood pressure readings before and after the surgery were noticeably higher after 10 min administration of anesthesia which reduces later on, which was also reported by Maryam Altuhafy[11] however the results reported by Ozge Anil et al[1] and Andrea Prol Castelo et al [10] shows no significant changes. Comparing the Study Group intervention to the Control Group procedure, this intergroup difference implies that the former was linked to better hemodynamic stability or a lower procedural stress response [25]. Systolic and diastolic blood pressure measurements showed a comparable pattern. Although the groups' baseline diastolic blood pressure levels were similar, the Control Group's diastolic values before and after the procedure were noticeably higher than those of the Study Group. During surgical procedures, elevated diastolic blood pressure may be a sign of elevated sympathetic tone and peripheral vascular resistance, which represent an increased stress response and insufficient analgesia or anxiolysis [26]. Patients with hypertension, coronary artery disease, or other cardiovascular risk factors may benefit from the Study Group's lower diastolic pressures, which indicate better procedural conditions and less hemodynamic stress [27].

The Experimental Group was substantially more comfortable than the Contro1 Group, according to the distribution of comfort ratings, which was found similar in studies of Maryam Altuhafy[11], Mahmut Sumer [13], Meet Shah [15] and Kunal Gajendragadkar et al [19]. Pain perception, anxiety management, physical placement, surroundings, and the entire procedure experience are all components of patient comfort, which is a multifaceted construct [28].

Study group shows quicker onset of anesthesia due to constant speed and low-pressure deposition which reduces chances of systemic toxicity which was also similar in study of Sohar Flisfisch[41] and Rodaina H. Helmy et al [21].

The cumulative benefits of reduced pain perception, quicker anesthetic onset, and better hemodynamic stability during the treatment are probably what caused the Study Group's noticeably higher comfort levels [29]. Improved patient comfort during surgery provides immediate therapeutic benefits, such as increased cooperation, less need for extra anesthesia, quicker recovery, and higher patient satisfaction and desire to undergo more procedures in the future [30]. According to the significant intergroup variation in comfort levels, the Study Group intervention significantly enhances the overall patient experience, making it a therapeutically recommended strategy from a patient-centric standpoint [23]. Comfort measurement is a useful endpoint in assessing novel anesthetic procedures and delivery systems, as evidenced by the study's findings about the association between comfort levels and clinically observable outcomes (such as hemodynamic stability and anesthetic effectiveness) [31].

CONCLUSION

Overall, the current study shows that patient outcomes were better for patients receiving the Study Group intervention than for those receiving standard treatment in regards to pain perception (decreased), time until successful anesthesia (faster), greater comfort during treatment (enhanced), and increased hemodynamic stability (lower blood pressures and less variability in blood pressure). Collectively, these findings support the clinical use of the Study Group intervention for the administration of local anesthetics and procedural sedation as routine practice. Nevertheless, the higher anxiety levels demonstrated within the Study Group requires further research to evaluate using a multimodal assessment technique, but this finding does not diminish any of the other outcome measures demonstrating significant therapeutic value for the Study Group intervention [32].

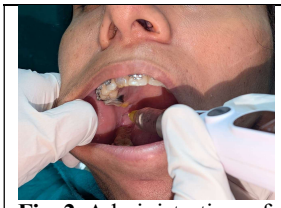


Fig 2 Administration of Inferior Alveolar nerve block using Computer controlled Local Anesthetic Drug Delivery Device

Fig 3 Monitoring of vitals

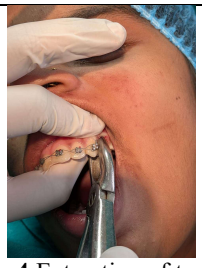


Fig 4 Extraction of tooth with respect to 24

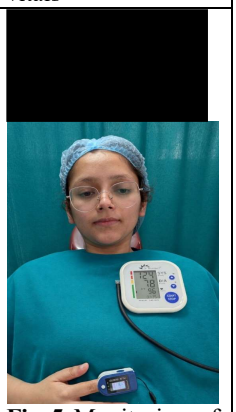


Fig 5 Monitoring of vitals (30 min, after the administration of Local Anesthesia)

BIBLIOGRAPHY

1. Anil Ö, Keskin G. Comparison of computer controlled local anesthetic delivery and traditional injection regarding disruptive behaviour, pain, anxiety and biochemical parameters: a randomized controlled trial. Journal of Clinical Pediatric Dentistry. 2024 Jan 1;48(1).
2. Janik K, Niemczyk W, Peterek R, Rój R, Balicz A, Morawiec T. Computer-Controlled Local Anaesthesia Delivery efficacy– a literature review. The Saudi Dental Journal. 2024 Aug 1;36(8):1066-71.
3. Baghlaf K, Elashiry E, Alamoudi N. Computerized intraligamental anesthesia in children: A review of clinical considerations. Journal of dental anesthesia and pain medicine. 2018 Aug;18(4):197-204.
4. Calatayud J, González Á. History of the development and evolution of local anesthesia since the coca leaf. Anesthesiology. 2003 Jun 1;98(6):1503-8.
5. Jung RM, Rybak M, Milner P, Lewkowicz N. Local anesthetics and advances in their administration–an overview. Journal of Pre-Clinical and Clinical Research. 2017 Jun 20;11(1):94-101.
6. Perugia P, Bartolino M, Docimo R. Comparison of single tooth anaesthesia by computer-controlled local anaesthetic delivery system (C-CLADS) with a supraperiosteal traditional syringe injection in paediatric dentistry. European journal of paediatric dentistry. 2017(18):3-221.
7. Friedman LM, Furberg CD, DeMets DL. Fundamentals of clinical trials. New York: Springer; 2015. p. 215-238.
8. Kwak EJ, Pang NS, Cho JH, Jung BY, Kim KD, Park W. Computer-controlled local anesthetic delivery for painless anesthesia: a literature review. Journal of dental anesthesia and pain medicine. 2016 Jun 30;16(2):81.
9. Schulz KF, Grimes DA. Generation of allocation sequences in randomized trials: chance, not choice. Lancet. 2002;359(9305):515-9.
10. Prol Castelo A, García Mato E, Varela Aneiros I, Sande López L, Outumuro Rial M, Abeleira Pazos MT, Rivas Mundiña B, Limeres Posse J. Evaluation of intraligamentous and intraosseous computer-controlled anesthetic delivery systems in pediatric dentistry: a randomized controlled trial. Children. 2022 Dec 30;10(1):79.
11. Altuhafy M, Sodhi GS, Khan J. Efficacy of computer-controlled local anesthesia delivery system on pain in dental anesthesia: a systematic review of randomized clinical trials. Journal of dental anesthesia and pain medicine. 2024 Jul 26;24(4):245.
12. Jones CM, Heidmann J, Gerrish AC. Children's ratings of dental injection and treatment pain, and the influence of the time taken to administer the injection. International journal of paediatric dentistry. 1995 Jun;5(2):81-5.
13. Sumer M, Koyuturk AE. Comparison of the Wand with a conventional technique. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2006 Jun 1;101(6):e106-9.
14. Yenisey M. Comparison of the pain levels of computer-controlled and conventional anesthesia techniques in prosthodontic treatment. Journal of Applied Oral Science. 2009 Oct;17(5):414-20.
15. Shah M, Shivaswamy S, Jain S, Tambwekar S. A clinical comparison of pain perception and extent of area anesthetized by Wand® and a traditional syringe. Journal of Indian Society of Periodontology. 2012 Apr 1;16(2):207-12.
16. Thoppe-Dhamodhara YK, Asokan S, John BJ, Pollachi-Ramakrishnan G, Ramachandran P, Vilvanathan P. Cartridge syringe vs computer controlled local anesthetic delivery system: Pain related behaviour over two sequential visits–a randomized controlled trial. Journal of

clinical and experimental dentistry. 2015 Oct 1;7(4):e513.
17. John JB. Behavioral response and pain perception to computer controlled local anesthetic delivery system and cartridge syringe Sharath Asokan, PR Geetha Priya, J Baby John, V Praburajan, R Punithavathy, TD Yogesh Kumar Department of Pedodontics and Preventive Dentistry, KSR Institute of Dental. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2015 Jul;33(3):223-8.
18. Aggarwal K, Lamba AK, Faraz F, Tandon S, Makker K. 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. Journal of dental anesthesia and pain medicine. 2018 Dec 28;18(6):367.
19. Gajendragadkar K, Bhate K, Jagtap B, SN S, Kshirsagar K, Magoo S. Making inferior alveolar nerve block more comfortable via computer-controlled local anesthetic delivery: a prospective clinical study. Journal of dental anesthesia and pain medicine. 2019 Jun 30;19(3):135.
20. Flisfisch S, Woelber JP, Walther W. Patient evaluations after local anesthesia with a computer-assisted method and a conventional syringe before and after reflection time: A prospective randomized controlled trial. Heliyon. 2021 Feb 1;7(2).
21. Helmy RH, Zeitoun SI, El-Habashy LM. Computer-controlled Intraligamentary local anaesthesia in extraction of mandibular primary molars: randomised controlled clinical trial. BMC Oral Health. 2022 May 20;22(1):194.
22. Malamed SF. Handbook of local anesthesia. 6th ed. St. Louis: Elsevier Mosby; 2013. p. 98-147.
23. Williams-Russo P, Charlson ME, MacKenzie CR, et al. Predicting post operative delirium: a prospective cohort study of cardiac surgical patients. JAMA. 1992;274(20):1549-56.
24. Thomas JJ, Mason KP, Mason KP, Mason KP. The anesthesia directed sedation service: Models, protocols, and challenges. In Pediatric sedation outside of the operating room: A multispecialty international collaboration 2011 Jun 24 (pp. 179-197). New York, NY: Springer New York.
25. Kehlet H, Holte K. Effect of postoperative analgesia on surgical outcome. British journal of anaesthesia. 2001 Jul 1;87(1):62-72.
26. De Hert S, Vlasselaers D, Barbé R, Ory JP, Dekegel D, Donnadonni R, Demeere JL, Mulier J, Wouters P. A comparison of volatile and non-volatile agents for cardioprotection during on-pump coronary surgery. Anaesthesia. 2009 Sep;64(9):953-60.
27. Bijker JB, Van Klei WA, Vergouwe Y, Eleveld DJ, Van Wolfswinkel L, Moons KG, Kalkman CJ. Intraoperative hypotension and 1-year mortality after noncardiac surgery. Anesthesiology. 2009 Dec 1;111(6):1217-26.
28. Kain ZN, Wang SM, Caramico LA, Hofstadter M, Mayes LC. Parental desire for perioperative information and informed consent: a two-phase study. Anesthesia & Analgesia. 1997 Feb 1;84(2):299-306.
29. Myles PS, Hunt JO, Fletcher H, Smart J, Jackson T. Part I: propofol, thiopental, sevoflurane, and isoflurane—a randomized, controlled trial of effectiveness. Anesthesia & Analgesia. 2000 Nov 1;91(5):1163-9.
30. Sneyd JR, Carr A, Irwin MG, et al. Prospective audit of role of non-steroidal anti-inflammatory drugs in acute severe headache. Br Med J.1992;305(6846):258-61.
31. Arendt KW, Townsend RM, Dowell ML, et al. Prophylactic use of intravenous calcium chloride for the prevention of hypocalcemia after massive transfusion: a pilot study. J Trauma. 2011;71(6):1505-12.
32. Apfelbaum JL, Silverstein JH, Chung FF, et al. Practice guidelines for perioperative blood transfusion and blood conservation. Anesthesiology. 2006;105(1):198-208.