Pain perception using a computer-controlled anaesthetic delivery system in paediatric dentistry: A review

N. Carugo*, L. Paglia*, D. Re**

*Department of Pediatric Dentistry, Istituto Stomatologico Italiano, Milan, Italy
**Department of Aestetic Dentistry, University of Milan, Milan, Italy

e-mail: n.carugo@gmail.com

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Abstract

Aim In paediatric dentistry it is essentials to reduce axiety and fear induced by local anaesthetic injection, in order to obtain patient's cooperation and achieve a successful treatment. Hence, this review is aiming to primary evaluate pain perception in paediatric patients when using a computer-controlled local anaesthetic delivery system (C-CLADS) compared to traditional injection.

Methods A database literature search was conducted on both MEDLINE and Cochrane Central Register of Controlled Trials and a data extraction table was created to perform a critical evaluation of each scientific article. The primary results were the perception of pain during anaesthesia and the patient's behaviour, the secondary the amount of anaesthetic required and its duration over time.

Results In the review were included 7 clinical studies regarding paediatric patients where split-mouth designs or group division were used. The age range was between 5 and 17 years old. Pain and fear parameters were measured by visual analogue scales, behavioural scales, heart rate and satisfaction questionnaires.

Conclusions Substantial heterogeneity between clinical trials was observed, which led to difficult comparison. Computerised devices have proved to be interesting in reducing pain during anaesthesia, improving the approach to the paediatric patient. It is advisable to conduct research with anxious subjects and patients under the age of 4, because no evidence has been found in the literature. It is recommended to conduct further research with anxious subjects and patients below the age of 4, where Relative Analgesia by Langa or pharmacological anxiolysis are frequently used.

KEYWORDS Anesthesia, Computer, Paediatric dentistry.

Introduction

Fear and anxiety have been reported as common experiences related to dental treatments. They are associated with local anaesthesia using syringes, a procedure recognised as one of the main causes of patients refusing to undergo dental treatment. These emotional conditions, causing pain and discomfort, predispose the patient to perceive an increased painful sensation. Anxious behaviour in adult patients can be traced back to traumatic experiences during paediatric treatments, therefore dentist should use devices and techniques to ensure a less painful injection for children. Pain perception can be reduced by using anaesthetic gel on the gingiva before injection, by distracting the patient with toys or children's TV programmes and by doing a slow injection, which is not easy to achieve with a traditional syringe due to the poor collaboration of the paediatric patient and the tissues' resistance such as palate and periodontal ligament. Computer-controlled local anaesthetic delivery system (C-CLADS) regulate the flow and pressure and therefore could be useful in paediatric dentistry. Many studies have compared the perceived pain levels with traditional or computerised injection. This review intends to analise the results to evaluate a rational use of computerised devices in paediatric dentistry.

Materials and methods

A literature search was performed on the MEDLINE databases via PubMed and Cochrane Central Register of Controlled Trials (CENTRAL) using the keywords anesthesia, computer, dental and pediatric. The search yielded a total of 24 scientific articles.

Following the elimination of duplicates, all abstracts were evaluated according inclusion and exclusion criteria (Table 1). The full text of the appropriate publications was obtained. The number of abstracts selected and the exclusion stage are shown in Figure 1. Part of the identified articles could not be used for the review since they were not meeting the criteria. A data extraction table was created to perform a critical evaluation of each article. The extracted data are references (author, year of publication); number, gender and age of participants; device and type of anaesthesia; dental treatment; evaluated parameters.

Results

Seven studies were considered relevant for this review (Table 2). The full texts of the publications were revised and data extracted (Table 3). A total of 477 paediatric patients participated in clinical trials, distributed in 263 males and 214 females. The average number of participants in each trial was 64 with a male ratio of 1.23:1. Only subjects aged between 5 and 17 years were included.

Mittal et al. [2019] and Perugia et al. [2017] split the patients into two numerically equal groups, randomly. The experimental group received anaesthesia by C-CLADS, while in control group

Inclusion criteria	Exclusion criteria
Using C-CLADS	Inability to obtain the full text
Publication within the last 3 years	Language other than English
Paediatric participants	Not relevant topic

TABLE 1 Inclusion and exclusion criteria of the study.

was used conventional infiltration. El Hachem et al. [2019], Chavhan et al. [2019], Patini et al. [2018] and Garret-Bernardin et al. [2017] used a split-mouth design. Each participant received two different types of injection in two separate consecutive visits, using a conventional syringe in one session and a computerised device in the other. The reduction of the bias was obtained by randomly choosing which technique to use as the first one in all trials. The patients were blindfolded with a mask [Patini et al., 2018] or had to close their eyes during the procedure [Garret-Bernardin et al., 2017]. In the study of Chavhan et al. [2019] only the statistician was blinded. The Wand system (Milestone Scientific, Inc.) was used in every trials (Fig. 2); dental treatments were performed after the anaesthetic infiltration. The aim of the trials was to evaluate pain perception during anaesthetic infiltration; pre-, intra- and post-anaesthesia pain and patient behaviour were recorded. Perugia et al. [2017] investigated duration of anaesthesia by measuring the response to an electrical stimulus. Visual analogue scales (Wong Baker, VAS, FPS, FIS, NVRS) and behavioural scales (Frankl scale, SEM scale, Vehnam scale) were used to detect subjective pain. In one trial [Garret-Bernardin et al., 2017] patient satisfaction was reported on a 1-10 scale. Heart rate was used as an objective parameter except for the research by Giannetti et al. [2018].

El Hachem et al. [2019] registered the time of injection initiation and parents were asked to inform the operator how long afterwards the anaesthetic effect lasted by asking the child; the number of cartridges required to obtain sufficient anaesthetic effect was also noted.

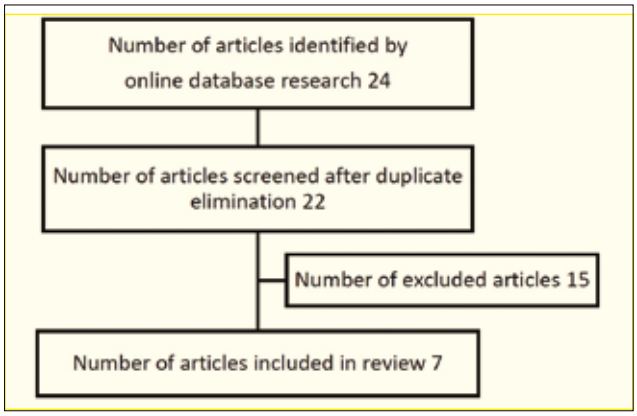

FIG. 1 Selection process flow chart.

1 *Metallic syringe vs electronically assisted injection system: a comparative clinical study in children.* El Hachem C, Kaloustian MK, Cerutti F, Chedid NR. *Eur J Paediatr Dent. 2019 Dec;20(4):320-324*

2 *Comparison of pain perception using conventional versus computer-controlled intraligamentary local anesthetic injection for extraction of primary molars.* Mittal M, Chopra R, Kumar A, Srivastava D. *Anesth Prog. 2019 Summer;66(2):69-76*

3 *Comparison of pain perception during the administration of local anaesthesia with computerized delivery system (WAND) and conventional technique in pediatric dental procedure using Visual Analogue scale-A randomised controlled trial.* Chavhan P, Jawdekar A, Deshpande S, Chandak S, Niswade G, Bhondey A. *Clinical epidemiology and global health, 2019*

4 *Single tooth anaesthesia: a new approach to the paediatric patient. A clinical experimental study.* Giannetti L, Forabosco E, Spinas E, Re D, Murri Dello Diago A. *Eur J Paediatr Dent. 2018 Mar;19(1):40-43*

5 *Dental anaesthesia for children - effects of a computer-controlled delivery system on pain and heart rate: a randomised clinical trial.* Patini R, Staderini E, Cantiani M, Camodeca A, Guglielmi F, Gallenzi P. *Br J Oral Maxillofac Surg. 2018 Oct;56(8):744-749*

6 *Pain experience and behavior management in paediatric dentistry: A comparison between traditional local anesthesia and the Wand computerized delivery system.* Garret-Bernardin A, Cantile T, D'Antò V, Galanakis A, Fauxpoint G, Ferrazzano GF, De Rosa S, Vallogini G, Romeo U, Galeotti A. *Pain Res Manag. 2017;2017:7941238*

7 *Comparison of single tooth anaesthesia by computer-controlled local anaesthetic delivery system (C-CLADS) with a supraperiosteal traditional syringe injection in paediatric dentistry.* Perugia C, Bartolino M, Docimo R. *Eur J Paediatr Dent. 2017 Sep;18(3):221-225*

TABLE 2 List of articles selected for review.

Reference	Number, gender, age of subjects	Device and type of anaesthesia	Dental treatment	Parameters evaluated
El Hachem C et al., 2019	30, 18 m. – 12 f., 6–8 y	Wand: BI Carpule: BI	Pulpotomy of deciduous molars	Wong Baker, VAS, Frankl scale, HR, quantity and duration of anaesthesia
Mittal M et al., 2019	82, 47 m. – 35 f., 6–13 y	Wand: STA Carpule: ILA	Deciduous molar extraction	SEM scale, HR, FPS
Chavhan P et al., 2019	106, 60 m. – 46 f., 5–12 y	Wand: PI, BI Carpule: PI, BI		VAS, HR
Giannetti L et al., 2018	66, 36 m. – 30 f., 6–17 y	Wand: STA	Restorative, extraction of deciduous and permanent	Wong Baker FIS, Frankl scale
Patini R et al., 2018	76, 38 m. – 38 f., 5–12 y	Wand: STA Carpule: ILA	Dental extraction	NVRS, HR
Garret-Bernardin A et al., 2017	67, 38 m. – 29 f., 7–15 y	Wand: STA Carpule: BI	Restorative, dental extraction	VAS, HR, Vehnam scale, patient satisfaction 1-10
Perugia C et al., 2017	50, 26 m. – 24 f., 5–13 y	Wand: STA Carpule: BI	Restorative, extraction of deciduous and permanent	Electrical stimulus response

**BI buccal infiltration, VAS visual analogue scale; HR heart rate; STA single tooth anaesthesia; ILA intraligamentary anaesthesia; SEM sound eye motor scale; FPS face pain scale-revisited, PI palatal infiltration, FIS faces image scale, NVRS numerical visual rating scale*

TABLE 3 The data extracted from the clinical trials included in the review.

FIG. 2 The delivery system used.

Discussion

The purpose of this paper is to review the data on pain and behaviour of paediatric patients associated with anaesthesia with computerised systems compared to conventional injection. Dentist should have a non-traumatic approach during the administration of anaesthesia because paediatric patients who report painful experiences in dental setting have a high probability of developing negligence or rejection in oral care in adulthood. Zilinsky et al. [2019] report how accurate needle insertion and slow anaesthetic advancement are common tricks used to reduce pain during conventional injection. C-CLADS regulate the flow and pressure during the administration of anaesthesia, promoting the reduction of pain due to a rapid injection. The results of the clinical trials included in the review are shown in Table 4.

El Hachem et al. [2019] did not observe statistically significant differences in perceived pain, patient behaviour, duration and amount of anaesthesia needed. Perugia et al. [2017] obtained longer anaesthetic effect with a more constant duration over time by using a C-CLADS. Need for a second injection was higher with conventional technique compared to C-CLADS [Patini et al., 2018].

In paediatrics a Face Pain Scale is commonly used to self-report measure of pain percieved; child's behaviour is also measured through behavioural scales that numerically quantify the patient's collaboration. In 5 studies [Mittal et al., 2019; Chavhan et al., 2019; Giannetti et al., 2018; Patini et al., 2018; Garret-Bernardin et al., 2017] were observed statistically significant differences in results when the computerised technique was used. Mittal et al. [2019] achieved a statistically significant reduction in pain measured with an FPS scale adapted to score 0-10 values. Chavhan et al. [2019] showed that the average value was 2.40 points using traditional technique and 2.02 points with C-CLAD, a result that was not statistically significant. Similar pain reduction is reported in two trials [Patini et al., 2018; Garret-Bernardin et al., 2017] with an average decrease of each 0.77 points and 1.09 points when CC-CLADS was used.

Heart rate was used as an objective parameter for measuring pain since it can be measured instrumentally. No statistically significant changes were recorded in two studies [El Hachem et al., 2019; Mittal et al., 2019] while the values were significant for Chavhan et al. [2019] only in the female gender. Other studies [Patini et al., 2018; Garret-Bernardin et al., 2017] demonstrate a significant reduction in heart rate during the injection when computerised systems were used, quantified by Garret-Bernardin et al. [2017] in an average decrease of 3.4 bpm.

Reference	Results
El Hachem C et al., 2019	No statistical differences were observed between the two techniques (p≤ 0.05) for all the parameters assessed.
Mittal M et al., 2019	HR ILA> HR C-CLADS but not statistically significant (p = .077) HR conventional extraction> HR C-CLADS statistically significant (p = .009) FPS - SEM ILA> FPS - SEM C-CLADS (p <.05)
Chavhan P et al., 2019	Significant difference in VAS scores in the 12-year age group; no significant difference in the range between 6 and 9 years. HR f. carpule> HR f. Wand (p = .015)
Giannetti L et al., 2018	91% of patients referred a positive experience(Frankl scale); 94% reported a positive evaluation (Wong Baker FIS); 100% effectiveness on deciduous teeth and 70% on permanent teeth.
Patini R et al., 2018	ILA pain 5.51 (SD 2.46) > C-CLADS pain 4.74 (2.8) (p = .04) HR ILA change 2.72 bpm (6.76) > HR C-CLADS change 0.34 bpm (7.3) (p = .04) Need for second injection ILA 21 > need for second injection C-CLADS 5
Garret-Bernardin A et al., 2017	VAS C-CLADS reduced by 1.09 points compared to VAS BI (p = .0003); HR C-CLADS reduced by 3.4 bpm compared to HR BI (p = .028); number of patients showing relaxed behaviour and patient satisfaction > with C-CLADS
Perugia C et al., 2017	Percentages of complete anaesthetic effect at time 0 and after 10, 20 and 40 minutes were respectively: BI 56%, 64% 76% and 72% - C-CLADS 88% 96% 96% 96% (p = .025; p = .005; p = .024; p = .024)

**SD standard deviation, bpm beats per minute*

Table 4 The results of the clinical trials included in the review.

Conclusions

This literature review showed a heterogeneity of results caused by numerous variables that made clinical trials difficult to compare with each other. Although some studies show a reduction in VAS scores and heart rate, the overall quality of scientific evidence is not sufficient to make an exhaustive judgment. The use of computerised devices has proved to be interesting in reducing pain during anaesthesia, improving the approach to the paediatric patient. It would be advisable to conduct further research on anxious subjects and patients under the age of 4, because no evidence has been found in the literature. For the treatment of these subjects, Relative Analgesia by Langa or pharmacological anxiolysis is frequently used; computerised anaesthesia could facilitate their treatment, leading the results to be more predictable and giving higher benefits to patients.

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