Pain perception in paediatric patients: evaluation of computerised anaesthesia delivery system vs conventional infiltration anaesthesia in paediatric patients

F. S. Ludovichetti[1], A. Zuccon[1], G. Zambon[2], G. Pellegrino[2], A. G. Signoriello[2], E. Milia[3], A. Bortone[4], A. Gracco[5], S. Mazzoleni[6]

Department of Neurosciences, Dentistry Section, University of Padova, Padua, Italy
[1] DDS, PhD, PhD, Adjunct Professor
[2] DDS, Resident
[3] DDS, Associate Professor, Department of Medicine, University of Sassari, Italy
[4] DDS, Dental Unit, Department of Surgery, Azienda Ospedaliera Universitaria, Sassari, Italy
[5] DDS, Associate Professor
[6] DDS, Aggregate Professor

e-mail: francesco.ludovichetti@unipd.it

DOI 10.23804/ejpd.2022.23.02.06

Abstract

Aim The aim of the present study is to compare the effectiveness of a computerised system (QuickSleeper) compared to traditional syringe in injection of local anaesthetic focusing on the perception of anxiety and pain in paediatric patients.

Methods Study design: 100 children aged between 3 and 15 years in need of two dental treatments that required local anaesthesia were selected and treated randomly but alternately with computerised and traditional local anaesthesia. After each anaesthetic injection, patient's anxiety was measured using the Venham test.

Results Electronic anaesthesia showed statistically significant better results than traditional anaesthesia according to the Venham pain scale, in both mandibular and maxillary sites. Statistics: Data were analysed using the paired Wilcoxon test.

Conclusions The computer-assisted anaesthesia system resulted in a significantly lower pain perception score and yielded to helpful, cooperative behaviour. For this reason, it is an advantageous alternative to traditional injection anaesthesia and can avoid invasive treatments and trauma for young patients.

KEYWORDS Pain perception; Computerised anaesthesia delivery sistem; Infiltration anaesthesia.

Introduction

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage [IASP, 1979]. Dental visits are often associated with pain, which may have a major influence on patient's cooperation, especially in children, with nervousness and complications during the treatment. In addition, these negative feelings experienced in the dental office persist in the memory of the individual even after they have reached adulthood [Nunna et al., 2019]. One of the major experiences behind dental anxiety is the infiltration of local anaesthesia, that is cause of fear in 25% of adults and reason for avoiding dental treatments in 5% of them [Milgrom et al., 1997]. Patients with fear of dental injections report increased pain during injections compared to non-fearful patients [Van Wijk et al., 2009]. This is even worse in children, where injections are often associated with many anxious thoughts and misconceptions [Milgrom et al., 1995]. As a result, there is a constant search for ways to reduce the invasiveness and pain caused by the injection, such as the use of pre-anaesthesia by topical anaesthetics [Franz-Montan et al., 2017] and the development of more comfortable ways of administering local anaesthesia before starting dental treatment. One of the most popular systems is the QuickSleeper, a computerised system that delivers local anaesthesia at a constant rate and pressure, allowing for completely painless anaesthesia without soft tissue numbness, effective in both conventional intra-mucosal infiltration and intraosseous administration [Smile-Faugeron et al., 2019]. The system allows three different injection modes: LOW (slow at constant speed), IO (intraosseous at progressive speed) and HI (fast at intense accelerated speed).

The aim of the present study is to compare the effectiveness of a computerised system (QuickSleeper) compared with traditional injection of local anaesthetic, mainly focusing on the perception of anxiety and pain in paediatric patients.

Materials and methods

The present study was conducted in light of an agreement between the University of Sassari and the University of Padua, which started in September 2019 and ended in June 2021. All treatments were performed at Borgo Cavalli Hospital in Treviso, Italy, by the same paediatric dentist. Written agreement was obtained from all patient's parents.

Ethical approval

Ethical approval was waived by the Ethics Committee of the University Padova; all patients gave their informed consent prior to the inclusion in the study.

Inclusion criteria

Children were selected as a convenience sample, i.e. all young patients who came for treatment during the study

period and met the selection criteria were selected.

Inclusion criteria included the following.

- Need for each child for two dental treatments that required local anaesthesia with or without vasoconstrictor.
- Age between 3 and 15 years.
- No known or suspected developmental or cognitive deficits.

Before starting the dental treatment, the Visual Analogue Scale (VAS) and the Venham Test were administered to the patients.

Methods

The study was conducted on 100 children aged between 3 and 15 years, with the consent of at least one parent. Each patient was treated receiving alternately and in different treatment sessions QuickSleeper anaesthesia and traditional local anaesthesia. A 30 gauge, 16 mm needle was used with the conventional syringe; DHT needle was used with the QuickSleeper system.

Pre-anaesthesia

Before both types of anaesthesia, a topical anaesthetic consisting of EMLA 2.5 mg/g + 2.5% mg/g cream (Lidocaine + Prilocaine) was applied using a cotton pellet to the dry mucosa of the injection site. This was left in place for at least 5 minutes before starting local anaesthesia.

After anaesthetic injection, patient's anxiety was measured using the Venham test [Venham et al., 1980].

Statistical analysis

Statistical analysis was performed by means of a commercially available statistical software package (RStudio, version 1.4.1717).

While performing the test to verify the homogeneity of the groups' variances in order to employ the t-test for paired data, it was realised that the p-value was less than 0.05 in each of the three tests and therefore the null hypothesis that the variances are equal was rejected and a non-parametric test was chosen instead. The results were analysed using the paired Wilcoxon test, a non-parametric test that does not require the assumption of normality of the data.

Results

Results were analysed at the University of Sassari.

The variables analysed in this study are: type of anaesthesia (traditional or electronic), age of the patient (Table 1), and injection site (mandible or maxilla).

A comparison of the variable referring to the patients' pain scale according to the type of anaesthesia is shown in Figure 1. In general, pain perception with electronic anaesthesia (red dots) is lower than with the traditional administration. In some cases, when a single coloured dot appears the values on the pain scale were the same for both types of anaesthesia. In Table 2, which summarises the the pain scale level by type of anaesthesia, it can be seen that when performed electronically anaesthesia had an average score of 1.28, while traditional anaesthesia had an average score of 2.25, i.e. electronic anaesthesia shows better results than traditional anaesthesia in the Venham pain scale. It is also noted that the maximum pain felt by child/adolescent when using traditional and electronic anaesthesia was scored 5 (highest) and 3, respectively.

For the statistical analyses, using Wilcoxon test, the data were divided into four groups as follows.

1. Traditional and electronic anaesthesia of the mandible (25 of the 100 patients): traditional anaesthesia had Vehnam pain scale scores of up to 5, while electronic anaesthesia reached a maximum score of 3 (in general the score of the second type range between 1 and 2 while the values of traditional anaesthesia are between 2 and 3) (Fig. 2). We can therefore see a lower perception of pain in the mandible when applying electronic anaesthesia to the jaw compared with traditional anaesthesia. The value obtained by the Wilcoxon test (7.883e-05) was below the 5% significance level ($\alpha = 0.05$). Therefore, for the mandible the null hypothesis is rejected. On average, the pain score was lower when electronic anaesthesia was applied.
2. Traditional anaesthesia of the mandible and electronic anaesthesia of the maxilla (25 of the 100 patients): it can be seen that the traditional anaesthesia is distributed between scores from 1 to 3, while the electronic is at 1 (Fig.

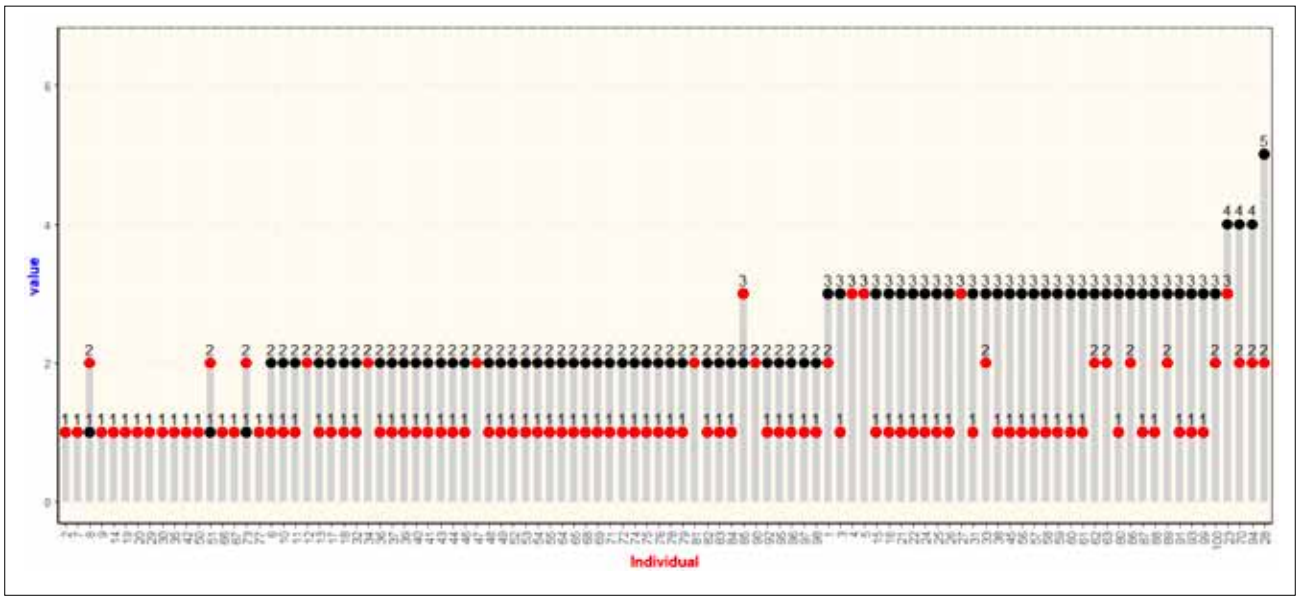

FIG. 1 Pain scale according to anaesthesia. Black dot: traditional anaesthesia; Red dot: electronic anaesthesia

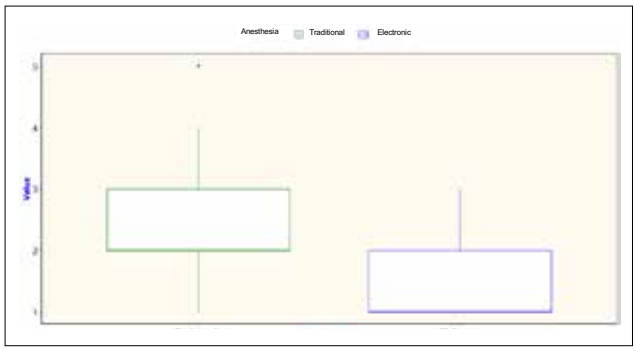

FIG. 2 Box plot related to the mandible.

FIG. 3 Box plot related to traditional anaesthesia in the mandible and electronic anaesthesia in the maxilla.

3), i.e. almost everyone felt no pain compared to when the first type of anaesthesia was traditional in the mandible and the second one was performed electronically in the maxilla. It was also observed that only one patient felt pain (score 3) when anaestesia was applied to the maxilla. The p-value obtained by the Wilcoxon test (0.0007) was below the 5% significance level ($\alpha = 0.05$), so the pain score in this situation was statistically significantly lower for the electronic type.

3. Traditional anaesthesia applied to the maxilla and electronic anaesthesia to the mandible (26 of the 100 patients): it can be seen that pain perception with the traditional type of anaesthesia is distributed between scores 1 to 3 (Fig. 4); however the concentration of the data is between 2 and 3, so patients felt some pain. Electronic anaesthesia, on the other hand, is almost at a score of 1, so almost everyone felt no pain. The p-value obtained by the Wilcoxon test (0.0000414) is lower than the 5% significance level, so the pain score in this situation was statistically significantly lower for the electronic type.
4. Both traditional and electronic anaesthesia applied to the maxilla (24 of the 100 patients): it can be observed that traditional anaesthesia had scores between 1 and 4, while electronic anaesthesia had a maximum of 3; scores of the second type are concentrated near 1, while in traditional anaesthesia they are between 2 and 3 (Fig. 5). Apparently, patients felt much less pain when electronic anaesthesia was used. The p-value obtained by the Wilcoxon test (0.0000365) is lower than the 5% significance level, so the pain score in this situation was statistically significantly lower for electronic anaesthesia.

FIG. 4 Box plot related to site of anaesthesia: traditional in maxilla and electronic in mandible.

Discussion

Nowadays, conventional anaesthesia is almost exclusively used in dentistry, but albeit this is a proven effective method, it has disadvantages compared to a computerised anaesthesia system. The most unfavorable condition described by patients is not just the needle insertion, but the pain exerted by the pressure of the local anaesthetic on soft tissue. This is due to the impossibility to apply a slow, constant and consistent pressure by the clinician, which is, on the other hand, guaranteed by a computerised system such as QuickSleeper and Wand, resulting in a less painful anaesthesia that ensures a correct and lasting effect. The aim of the present study was to evaluate the impact of QuickSleeper anaesthesia in a sample of 100 children aged between 3 and 15 years. The sample was divided into four numerically identical groups, as reported by Mittal et al. [2015] in which one group was treated with QuickSleeper anaesthesia and the control group with traditional anaesthesia; the division of patients into the two groups was completely random.

In literature there are several studies evaluating and comparing the effectiveness of the two anaesthetic systems, but not all of them refer to paediatric patients. Yesilyurt C. et al. [2008] compared computer-assisted and conventional systems, on 40 patients aged between 18 and 30 participating in the study. However, age is an important inclusion factor because it complicates the treatment for the following reasons:

- age of the young patient;
- family involvement;
- increased difficulty in carrying out treatment over time;
- positive reinforcement;
- use of aids (audiovisual and small games);
- empathic relationship between the patient and the dentist.

Min.	1st Qu.	Mean	3rd Qu.	Max	CV
3	7	8.62	11	15	34.30%

TABLE 1 Position and dispersion measurements of the age variable.

Anesthesia	Min.	1st Qu.	Median	Mean	3rd Qu	Max
Traditional	1	2	2	2.25	3	5
Electronic	1	1	1	1.28	1	3

TABLE 2 Summary measures of the variable pain scale by anaesthesia type.

FIG. 5 Box plot related to the site of anaesthesia: maxilla.

One of the most common methods for analysing pain perception is the VAS visual analogue scale. This consists of a range of values between 0 and 10, where 0 indicates the minimum value defined as 'no pain' and 10 the maximum value defined as 'severe pain'. However, each child has a different and specific pain threshold, so physical reactions to a stimulus may vary from child to child in a totally subjective way [Chapman et al., 2002]. Since the VAS scale is very subjective, the Venham test was used in this study to measure pain perception. Venham test is an objective test where the value is specified by the dentist himself, trying to minimise possible variations caused by the operator's manual skills [Venham et al., 1980].

In the present study, we used the Venham scale regardless of the site where anaesthesia was applied, whether it was the mandible or the maxilla. With electronic anaesthesia the maximum perceived value was 3 compared to 5 with conventional anaesthesia: the relative improvement in the perception of the pain scale is clearly evident. Also when assessing the perception of pain after each injection, using electronic anaesthesia, an average of 1.28 was obtained, compared with 2.25 when using traditional anaesthesia. Application of electronic anaesthesia was 4 times longer than standard anaesthesia, due to the slow and steady speed and pressure of the computer system. The Venham pain scale used for both the mandible and maxilla has statistically significantly lower scores when considering electronic anaesthesia. Indeed, the pen-shaped device allows better support, close to the injection site, leading to an easier and less painful needle penetration.

Currently, most studies on electronic anaesthesia concern the Wand system. Vesloot et al. [2008] carried out a study on 147 children. Selection criteria included: need for two successive treatment sessions requiring local anaesthesia, age between 4 and 11 years with no cognitive deficit; randomly assigment to wand anaesthesia or traditional injection. In contrast to our study, no statistically significant difference was found between the two types of anaesthesia; however, in Vesloot's study the injections were administered by two different dentists, resulting in greater intra-operator variables. Moreover, Wand and QuickSleeper systems differ in the way anaesthetic is released.

More similar to our work is the study by Smaïl-Faugeron et al. [2019], who compared the same QuickSleeper system in the intraosseous mode with conventional infiltration anaesthesia. The mean VAS scores were 1.17 ± 1.40 cm for QuickSleeper and 1.86 ± 1.81 cm for conventional groups. The mean for the difference in paired proportions was -0.69 ± 0.29 cm (-1.25 to -0.12), showing that patients felt statistically significantly less pain at needle insertion and injection. Smaïl-Faugeron included in the study young patients with MIH (molar-incisor hypomineralisation) who exhibited significantly higher levels of anxiety on the Venham scale; whereas in our study these patients were excluded. Our results are therefore in accordance with the studies mentioned above, showing that anaesthesia performed with a traditional syringe produced significantly more discomfort in children than computerised systems. In future, a comparison between the two computer systems (QuickSleeper and Wand), could be interesting to perform.

Conclusion

By comparing statistical data between the two systems used in the study, the following conclusions can be drawn.

1. Traditional anaesthesia resulted in a higher pain perception score and more hostile and uncooperative behaviour.
2. QuickSleeper computer-assisted anaesthesia system resulted in a significantly lower pain perception score and helpful, cooperative behaviour. The constant pressure and slow speed contributed to the success of the treatment but, at the same time, the duration of the procedure can be difficult to manage, that is why for real success of the treatment it is essential to be able to entertain the child.

In conclusion, the Quicksleeper computerised system can represent an advantageous alternative to traditional injection anaesthesia and can avoid invasive anaesthesia treatments and trauma for young patients.

References

- Chapman HR, Kirby-Turner N. Visual/verbal analogue scales: examples of brief assessment methods to aid management of child and adult patients in clinical practice. Br Dent J 2002; 193: 447–450.
- Franz-Montan M, Ribeiro LNM, Volpato MC, Cereda CMS, Groppo FC, Tofoli GR, de Araújo DR, Santi P, Padula C, de Paula E. Recent advances and perspectives in topical oral anesthesia. Expert Opin Drug Deliv 2017 May;14(5):673-684.
- IASP Subcommittee on Taxonomy. Pain terms: a list with definitions and notes on usage. Pain 1979 Jun;6(3):249.
- Milgrom P, Coldwell SE, Getz T, Weinstein P, Ramsay DS. Four dimensions of fear of dental injections. J Am Dent Assoc 1997 Jun;128(6):756-66.
- van Wijk AJ, Hoogstraten J. Anxiety and pain during dental injections. J Dent 2009 Sep;37(9):700-4.
- Milgrom P, Mancl L, King B, Weinstein P. Origins of childhood dental fear. Behav Res Ther 1995 Mar;33(3):313-9.
- Mittal M, Kumar A, Srivastava D, Sharma P, Sharma S. Pain Perception: Computerized versus traditional local anesthesia in pediatric patients. J Clin Pediatr Dent 2015 Fall;39(5):470-4.
- Nunna M, Dasaraju RK, Kamatham R, Mallineni SK, Nuvvula S. Comparative evaluation of virtual reality distraction and counter-stimulation on dental anxiety and pain perception in children. J Dent Anesth Pain Med 2019 Oct;19(5):277-288.
- Smaïl-Faugeron V, Muller-Bolla M, Sixou JL, Courson F. Evaluation of intraosseous computerized injection system (QuickSleeper™) vs conventional infiltration anaesthesia in paediatric oral health care: A multicentre, single-blind, combined split-mouth and parallel-arm randomized controlled trial. Int J Paediatr Dent 2019 Sep;29(5):573-584.
- Venham LL, Gaulin-Kremer E, Munster E, Bengston-Audia D, Cohan J. Interval rating scales for children's dental anxiety and uncooperative behavior. Pediatr Dent 1980 Sep;2(3):195-202.
- Versloot J, Veerkamp JS, Hoogstraten J. Pain behaviour and distress in children during two sequential dental visits: comparing a computerised anaesthesia delivery system and a traditional syringe. Br Dent J 2008 Jul 12;205(1):E2; discussion 30-1.
- Yesilyurt C, Bulut G, Taşdemir T. Pain perception during inferior alveolar injection administered with the Wand or conventional syringe. Br Dent J 2008 Sep 13;205(5):E10.