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Pain assessment by children and adolescents during intraosseous anaesthesia using a computerized system (QuickSleeper™)

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Background. Intraosseous (IO) anaesthesia has been shown to be effective in children. However, the pain associated with anaesthetic injections, and its acceptance by children, have never been studied.

Aim. The aim of this study was to assess the pain associated with the IO injection of 4% articaine with 1 : 200 000 epinephrine using the computerized QuickSleeper' system in a population of children and adolescents.

Design. IO anaesthesia was performed on patients aged 10.4 ± 2.6 years of age. The patients assessed their pain on a faces pain scale (FPS) and on a visual analogue scale (VAS). The operators were also asked to assess signs of patient pain/discomfort.

Results. No pain or mild discomfort was reported by, respectively, 81.8% (FPS) and 83.9% (VAS) of the patients. Some 58.9% of children with previous experience of dental anaesthesia reported that computerized IO anaesthesia was more comfortable than traditional infiltration methods. Operators noted signs of discomfort during penetration and injection in 18.3% and 25.3% of the patients, respectively.

Conclusions. This study showed that the majority of children reported no pain or mild pain when anaesthetic was administered by computerized needle rotation and solution deposition. This technique holds promise for use by trained paediatric dentists.

Introduction

Dental anaesthesia, because it is mainly associated with pain, is one of the most important factors related to fear and discomfort in children and adolescents[1–4]. The delivery of local anaesthetic solutions and the puncturing the mucosa by the needle during traditional infiltration procedures can be uncomfortable in spite of topical anaesthesia and computerized systems to deliver the anaesthetic at a constant rate and pressure. Infiltration methods (buccal infiltration, mandibular nerve block, etc.) may also be associated with mucosal numbing and self-biting of soft-tissues. Intraosseous (IO) injections, which are an alternative to traditional infiltration techniques, make it possible to inject local anaesthetic directly in the cancellous bone adjacent to the tooth to be anaesthetized. Most studies of IO anaesthesia have been performed on adults using slow-speed, handpiece-driven perforators that drill a small hole through the cortical plate in order to inject anaesthetic through the hole using a traditional syringe. In a recent study, a new device that combines computerized needle rotation for osseous perforation and an anaesthetic delivery system (QuickSleeper') was tested in a population of children[5]. The overall success rate was 91.9%, with mild numbing of soft tissues reported by 6.5% of the children. IO injections can thus be an effective primary technique for producing local anaesthesia in children that combines efficacy and a lower risk of soft tissue injuries caused by self-biting. The aim of this pilot study was to assess the pain caused by the IO injection of anaesthetic using the QuickSleeper' system in a population of children and adolescents aged 6–16 years.

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Materials and methods

Population

Children and adolescents attending the Department of Paediatric Dentistry at Rennes University Dental Hospital (Brittany, France) were recruited for this study. They were free of general pathologies and were being treated for usual dental diseases. They had to be above 6 years of age and not exceed a score of 2 using a modified Venham behaviour scale[6]. None of the patients was treated under conscious sedation or received any treatment that could modify their behaviour or awareness of pain. The differences between the infiltration methods were explained to the patients and/or their parents. They provided informed consent for the procedure. Our study was approved by the ethics committee of the hospital, and was conducted in full accordance with accepted ethical principles. Fifty patients (24 girls and 26 boys, mean age 10.40 ± 2.59 years) were included in the study. Seventy-seven teeth (25 primary teeth, 34 permanent mandibular molars, and 18 other permanent teeth) were treated in 71 sessions.

Materials

The computerized QuickSleeper‘ (DHT, Cholet, France) system was used. A foot pedal was pressed to activate the rotation of the needle. A second foot pedal was pressed to activate the slow injection of anaesthetic solution (Fig. 1). A 30-gauge, 9-mm-long Intra-LigS (SOFIC, BP 282, 81209 Mazamet, France) needle was used to inject 4% articaine with 1 : 200 000 epinephrine. An initial 0.4 mL volume of anaesthetic solution was injected. More anaesthetic was injected as required[5], for a mean total of 1.08 ± 0.36 mL.

IO injection procedure

The IO injection procedure was performed by staff dentists of the Department of Paediatric Dentistry at Rennes University Dental Hospital. The dental treatments were performed by staff or dental students of the Department of Paediatric Dentistry. A three-step procedure

Fig. 1. Computerized QuickSleeper™ system (computer and syringe). A double foot pedal allows to control needle rotation and anaesthetic solution delivery.

was used for the IO technique, including anaesthesia of the mucosa, computerized rotation of the needle to penetrate the cancellous bone, and computerized injection of the anaesthetic solution (Fig. 2)[5].

Pain assessment

At the end of the dental treatment session, the children were asked to answer a questionnaire. A trained dentist not involved in the IO procedure and/or dental treatment of the patients posed the questions. The patients assessed their pain using a faces pain scale (FPS) ranging from 1 (no pain) to 6 (very much pain)[7] and a visual analogue scale (VAS) ranging from 0 (no pain) to 10 (very much pain). The patients were also asked to compare the computerized anaesthetic procedure with previous experience(s) of dental anaesthesia. The operators assessed patient pain during the procedure using the VAS scale, and recorded signs of pain or discomfort during the mucosal/osseous penetration of the needle or the injection of the anaesthetic solution (muscle tension, body movements, crying/shouting, verbal protests, resistance).

Statistical analysis

The results were analysed using either the chi-squared test or the Fisher's exact test. Comparisons were considered significant at $P < 0.05$.

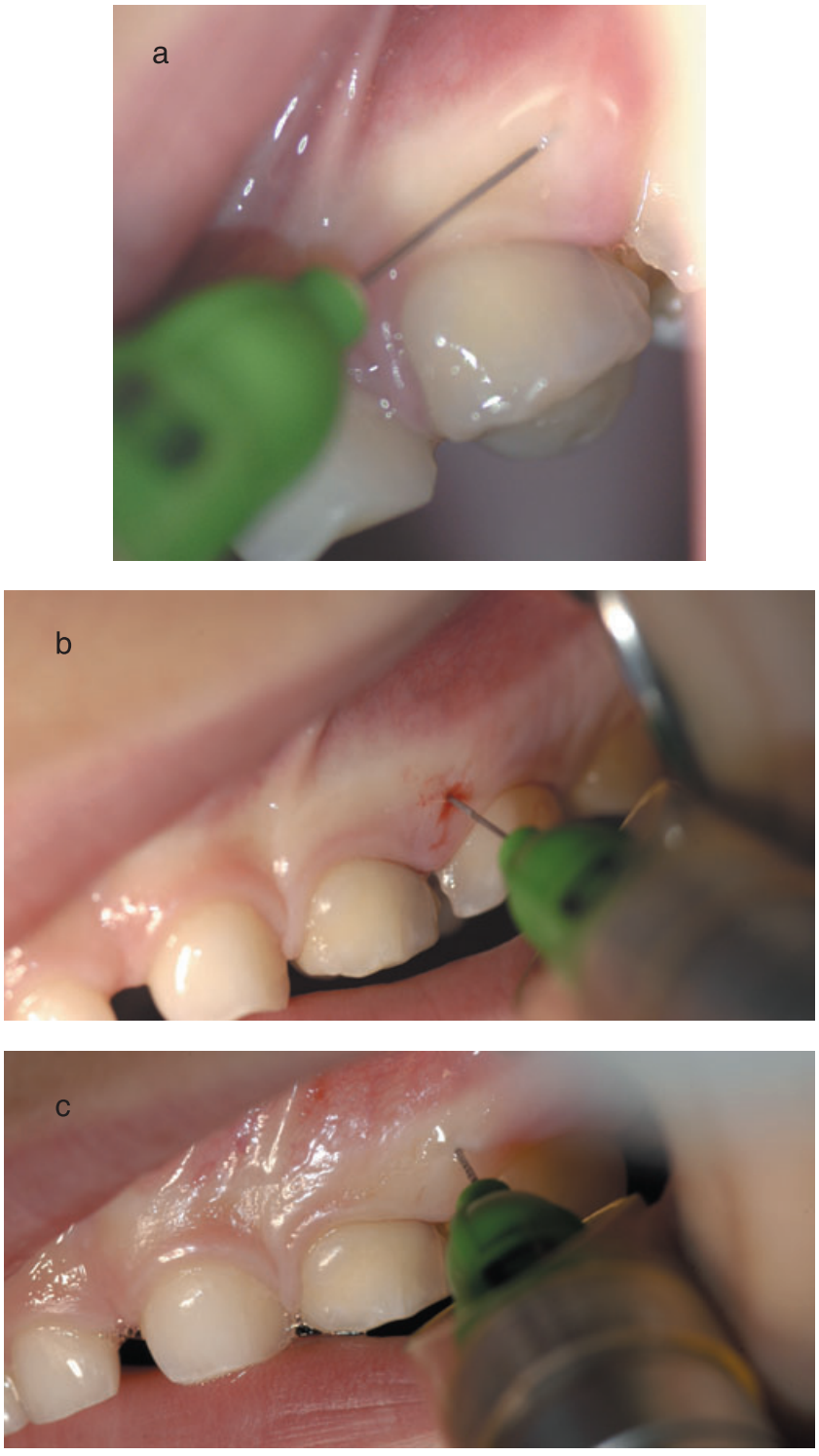

Fig. 2. Intraosseous injection procedure. The needle is first orientated with the flat surface of the bevel facing the mucosal surface. It is inserted at a shallow angle (a) and the anaesthetic is injected (note blanching of gingiva caused by the diffusion of the anaesthetic solution). The needle is repositioned at a 90° angle to the gingival surface until it comes into contact with the bone (b). The needle rotates and penetrates the cancellous bone. The anaesthetic is then injected (c). The plastic circle is positioned to protect soft tissues as the needle rotates.

Results

There were no differences between girls and boys according to age, distribution of teeth treated, or type of treatment. In most cases, a single 1 s rotation of the needle was required for IO perforation. The mean volume of anaesthetic solution injected was 1.08 ± 0.36 mL, which corresponded to a 0.6 cartridge. Supplemental intraseptal anaesthesia was required in two sessions (2.8%). The treatments performed are described in Table 1.

Table 1. Treatments performed.

Type of tooth	Endodontic treatment	Medium depth cavities	Deep cavities	Extractions
Primary teeth	12	6	0	1
Permanent mandibular molars	6	8	18	2
Other permanent teeth	1	3	6	6

Table 2. Distribution of scores using the Faces Pain Scale and correlation with signs of pain rated by the operators during intraosseous deposition of anaesthetic solution.

Scores	No pain*	Pain*	Total
Face 1	21	2	23
Face 2	26	7	33
Face 3	5	6	11
Face 4–6	0	3	3

The operators noted signs of discomfort during penetration and injection in 13 (18.3%) and 18 (25.3%) cases, respectively. FPS scores were obtained in 70 sessions. The majority of the patients reported an FPS score of 1 (no pain: 23 of 77; 29.9%) or 2 (mild pain: 33 of 77; 42.9%) (Table 2). There were no differences according to type of tooth (primary versus permanent), age (≤ 10 vs. > 10), gender, type of treatment, or session rank (first session versus following sessions). There was no difference in the distribution of FPS scores related to discomfort or pain during penetration. However, there was a statistically significant lower FPS score (1 or no pain) for dentist-assessed discomfort and/or pain during injection (chi-squared = 5.19; d.f. = 1; $P = 0.0226$). FPS scores above 2 were associated with discomfort/pain during injection ($P = 0.0007$; Fisher's test).

Scores using the VAS scale were recorded in 56 sessions. No pain (score = 0; 15 of 56) and mild pain (scores = 0.1–2; 32 of 56) were reported by 83.9% of the children and adolescents using the VAS scale (Fig. 3). There were no differences according to age, gender, treatment, teeth treated, or session rank. There was no difference in the distribution of VAS scores related to discomfort or pain noted during penetration. The mean VAS scores were, respectively, of 1.0 ± 1.0 (no pain or discomfort noted during injection) and 1.8 ± 1.6 (pain or discomfort detected during injection of the anaesthetic solution).

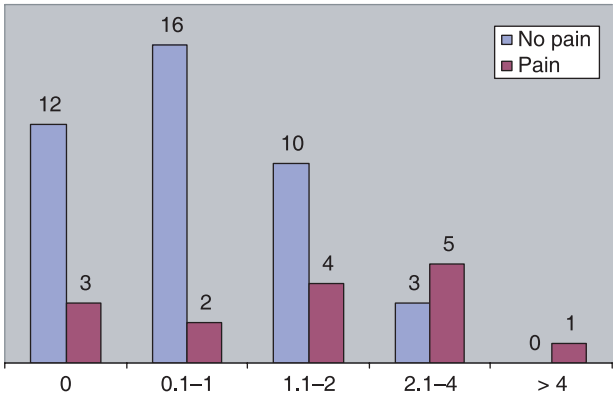

Fig. 3. Distribution of scores using the visual analogue scale and correlation with signs of pain rated by the operators during intraosseous solution deposition.

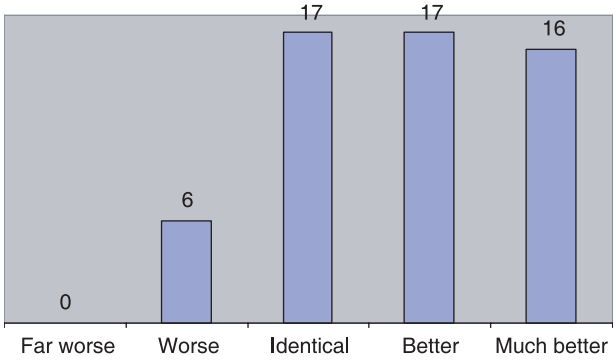

Fig. 4. Comparison with previous experiences with a traditional syringe.

VAS scores above 2 were significantly more frequently reported when pain was noted during injection ($P = 0.0078$; Fisher's exact test). Comparisons with previous experiences of dental anaesthesia using the traditional procedure were obtained in 56 cases (Fig. 4). The children reported that the IO procedure was better or much better than the traditional procedure in 58.9% of cases (33 of 56). There was no difference with respect to previous experiences of mandibular block (mandibular first molars) and buccal infiltration (other teeth). In addition, there were no differences

between teeth treated, age, gender, type of treatment, session rank, or pain/discomfort during needle penetration or IO injection.

Discussion

Very few studies on IO injections in children and adolescents have been published. IO injections have high efficacy rates[5], but are rarely used in young patients. There are many reasons for this, including the fact that some dentists find osseous perforation psychologically aggressive for patients, and perhaps for themselves, and that most studies have used handpiece-driven perforators and conventional syringes. This study is the first to assess how children and adolescents assess and accept IO anaesthetic injections. We used the computerized QuickSleeper' needle rotation and anaesthetic injection system, which prevents tissue overheating during drilling and delivers the anaesthetic solution at a lower rate, which theoretically causes less IO pressure during injection and therefore less pain.

This study was performed on a small cohort of patients in which anxious and highly anxious children were excluded. Furthermore, IO was performed by a small number of trained practitioners that might have influenced the process. Therefore, results have to be considered both with respect to these points.

There are no previous studies on IO anaesthesia for comparison. However, similar self-assessed pain scores by children have been reported in studies of other computerized dental infiltration procedures[8–11]. The level of dental anxiety is an important factor in the responses of children to dental anaesthesia. Very anxious children report more pain and display more pain-associated behaviour and distress related to local anaesthetic injections[2,12,13]. This study was restricted to patients whose anxiety was classified using the Venham modified score as low (0 or 1) or medium (2). This may explain in part the positive results we obtained. In addition, the QuickSleeper' device is not syringe shaped and was readily accepted by younger patients as a 'magic pen', indicating that the physical appearance of a dental injector is of importance to children[14].

Although signs of pain/discomfort during mucosal anaesthesia and osseous perforation were noted by the operators, they were not related to high pain scores. In previous studies involving adults that compared IO injections with traditional syringes and computerized devices, self-assessed pain ratings were higher during the initial steps of the traditional procedure (46–88% during needle insertion and/or solution deposition in the gingiva) than during the computerized procedure (perforation, needle insertion, and IO delivery). Pain related to osseous perforation was mild to moderate in 8–78% of these cases, with 0–15% of patients reporting severe pain[15–19]. The lower pain/discomfort scores reported in this study during the initial steps may be explained by the insertion of the needle using the flat part of the bevel and the lower intragingival pressure associated with the computerized injection of the anaesthetic solution. During the first 30 s, the QuickSleeper' system delivers the anaesthetic solution drop by drop. In most cases, a single 1 s rotation was required to insert the needle in the cancellous bone, which is in agreement with a previous study[5] and is likely caused by the thinness of the cortices and lower bone density in children and adolescents. In addition, potential fear or discomfort may have been moderated by the fact that there was no overheating of the bone and that only a short time was required to insert the needle.

Although there was a statistically significant relationship between high pain scores and signs of pain during deposition of the anaesthetic in the bone in this study, mild to moderate discomfort during the deposition with a traditional syringe of the anaesthetic solution has been reported in adults[15–19]. It is hard to evaluate the influence of the computerized delivery of anaesthetic solution. Some studies have reported lower self-assessed pain scores with computerized devices than with traditional syringes after buccal infiltration[10,11], whereas others have not[8,9,13,20]. No or lower disruptive behaviour has been noted in most studies comparing IO with traditional syringes when the assessments are based on pain behaviour[8,9,13,20,21].

Conclusion

This study is the first to assess pain related to the IO injection of anaesthetic in a population of children and adolescents. This descriptive study has been performed on a small cohort and, without an appropriate control group, conclusions need to be carefully drawn. The procedure was well accepted by the young patients when a computerized system was used to perforate the bone and deliver the anaesthetic solution. In most cases, no or mild pain was reported by the children or noted by practitioners. Our results suggest that this procedure is efficient and reduces the numbing of soft tissues and self-biting, leading to the conclusion that it could be considered a good alternative or supplement to classic infiltration techniques in children and adolescents. However, a randomized study with a control population is needed to better evaluate the discomfort or pain related to IO injections in children.

What this paper adds

- Children and adolescents tolerated computerized IO anaesthesia very well.
- Patient-assessed pain scores were low. Higher scores were mainly related to IO injection rather than osseous penetration.

Why this paper is important to paediatric dentists

- This paper shows that computerized IO anaesthesia is effective and well tolerated. As such, dentists can use it as an alternative or complement to traditional infiltration techniques.
- This technique can be used as a primary dental anaesthetic procedure in many cases.

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