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Efficacy of Computer-Controlled Articaine Delivery for Supplemental Intraoral Anaesthesia

SUMMARY

Objective. *The* **aim** *of this study was to investigate quality and safety of supplemental intraoral anesthesia - periodontal ligament anaesthesia (PDL) and intraseptal anaesthesia (ISA) after computer-controlled articaine delivery.*

Method. *54 ASA I volunteers randomly divided into 2 groups participated in this study. 0.4 ml of 4% articaine with 1:100.000 epinephrine were randomly administered with computer-controlled local anaesthetic delivery system on the mesial and distal side of maxillary lateral incisor for ISA or PDL. An electric pulp tester was used to test the pulpal anaesthesia, in 2-minute cycles for 60 minutes. Anaesthesia was considered successful when 2 or more consecutive no-response at 80 readings were obtained. Soft-tissue anaesthesia was measured by pin-prick test.*

Results. *Success rates for ISA and PDL were 77.8% and 55.6% respectively, but difference was not statistically significant ($p>0.05$). Duration of complete pulpal anaesthesia was significantly longer ($p<0.05$) with the ISA in comparison to the PDL. The width of anesthetizied field was significantly greater ($p<0.05$) with the ISA than with the PDL, both for attached gingiva and oral mucosa. No side effects were recorded during the study.*

Conclusion. *The results of this study indicate that the ISA technique is successful in obtaining complete pulpal anaesthesia of upper lateral incisors and soft-tissue anaesthesia in this area.*

Keywords: Intraseptal Anaesthesia; Periodontal Ligament Anaesthesia; Articaine; Computer-controlled local anaesthetic delivery system

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Introduction

Achieving adequate anaesthesia of dental pulp and periodontium is imperative in performing most dental procedures. Beside conventional anaesthetic techniques, infiltration and nerve block, some additional anaesthetic techniques may be required[11]. Some recent advances in anaesthetic techniques that provide alternatives to conventional methods include periodontal ligament anaesthesia (PDL) and intraseptal anaesthesia (ISA)[6,11]. PDL is effective for pulpal, osseous and soft tissue anaesthesia[2,12]. In addition, PDL provides anaesthesia only in the localized area without unpleasant numbness of the lip and facial muscles[12]. However, PDL has some disadvantages, such as possible injury to the periodontal ligament[17] and spread of infection from injection site deeper into the alveolar bone if injection site is inflamed[18].

In order to overcome disadvantages associated with PDL, intraseptal anaesthesia (ISA) may be used. ISA is an intraoral anaesthetic technique where needle penetrates periosteum in the region of interdental osseous septum and anaesthetic diffuses directly into cancellous bone, reaching apical nerves of teeth[1,21]. It is a local anaesthetic technique that can provide osseous, soft tissue and pulpal anaesthesia in patients undergoing tooth scaling, periodontal surgery and simple tooth extractions[3,18].

Computer-controlled local anaesthetic delivery system (CCLADS) delivers anaesthetic at a constant, slow rate and controlled pressure, regardless of the

tissue resistance[7]. CCLADS provides less painful injections than traditional system[19,22]. Likewise, this system enables clinicians to perform easier, faster, more reliable and less painful dental anaesthesia and is better accepted by patients than standard method of injection[4]. Traditionally, PDL and ISA have been used with a conventional or high pressure syringe[10,11,12] with the possibility to change parameters of the cardiovascular function[3,15]. However, Nusstein et al[13] reported that PDL used with CCLADS did not cause neither significant nor clinically meaningful increase in heart rate. Evaluation of the anaesthetic parameters showed that duration of complete pulpal anaesthesia using CCLADS with PDL was about 30 minutes in comparison with conventional pressure syringe where duration was 10-15 minutes[2,8,9].

The **aim** of this study was to investigate quality and safety of the intraoral supplemental anaesthesia (PDL and ISA) after computer-controlled articaine delivery (CCArtD).

Method

54 randomly selected ASA I volunteers participated in this study. All patients were informed of the goals of the study and signed a written consent. The study was approved by the Etical Committee of the Faculty of Dentistry, University of Belgrade. Persons were randomly divided into 2 groups: (1) the 1st group (27 volunteers) undergone the ISA; (2) the 2ndgroup (27 volunteers) undergone the PDL. The tested tooth was upper lateral incisor. Previous clinical examination indicated that all the tested teeth were free of caries, large restorations or periodontal disease, and none had a history of trauma or sensitivity.

The local anaesthetic injected was 4% articaine with 1:100 000 epinephrine (Septanest ®, Septodont, France). The total dose of anaesthetic solution was 0.4 ml per tooth, both for ISA and PDL. Time of local anaesthetic administering, 0.2 ml mesially and 0.2 ml distally, was approximatelly 80 seconds (40 seconds at each side). Anaesthetic solution was injected with computer-controlled local anaesthetic delivery system (Anaeject®, Septodont, France) with constant pressure and speed, approximately 0.005 ml per second.

The site of needle insertion for ISA was 2-3 mm above the tip of interdental papilla, with 90° angulation of the needle to the surface of the papilla, until contact with the bone. Blanching of the gingiva overlying bone was indicator that the anaesthetic solution had been properly deposited. The site of needle insertion for PDL was the region of gingival sulcus at 30° to the tooth long axis at bucomesial and bucodistal aspect of the rooth. We used a 30G short needle (Septodont®, Dental Needle, France), both for ISA and PDL.

Duration and success of pulpal anaesthesia of the upper lateral incisor were evaluated using tooth vitality tester (Vitality Scanner Model 2006®, Sybron Endo). Fluoride gel (Fluorogal forte®, Galenika, Beograd) was used as an electrolyte between the pulp tester probe and the tooth. Before the injections were given, the experimental tooth and control contralateral canine were tested 3 times by means of a Vitality Scanner, Model 2006, to record baseline vitality. After administering anaesthesia, electrical stimulation was repeated every 2 min until the reading became lower than 80 (max). Duration of complete pulpal anaesthesia was period between the first and the last 80 readings on electrical pulp tester. Anaesthesia was considered successful when 2 or more consecutive no response at 80 readings were obtained.

Soft tissue anaesthesia was measured as absence of pain when pin-prick test was used in the region of the attached gingiva. The width of the anaesthetic field, expressed in millimetres, was measured 5 min after the local anaesthetic injection by flexible ruler and pinprick testing in the region of the attached gingiva and oral mucosa. We used 27 gauge needle (MonoJect®, Dental Needle, Mansfield, USA) for pin prick testing. Pinprick testing was done directly until contact with the periosteum occured, immediately after the end of injection, every 5 min during the first 20 min, and after that every 2 min until patient felt blunt pain.

Patients were followed for 5 days to record any local postoperative side-effects, such as postoperative sensitivity to bite, papillary necrosis, postoperative pain or swelling.

Statistical analysis was performed by using statistical software SPSS, version 10.0. The results were analysed by unpaired t-test (2-tailed), Man-Whitney non-parametric test and χ^2 test.

Results

There were no statistical significant differences ($p>0.05$) between the groups in respect to the success rate of pulpal anaesthesia achieved by both techniques; ISA being slightly more successful (77.8%) than PDL (55.6%).

Significantly wider area of the anesthetized attached gingiva and oral mucosa at the buccal aspect of the tooth were obtained by ISA in comparison with PDL (Tab. 1).

Duration of complete pulpal anaesthesia (Tab. 2) was significantly longer with ISA than with PDL ($p<0.05$). Likewise, duration of soft tissue anaesthesia was significantly longer with ISA than with PDL ($p<0.05$).

No local side effects were recorded during the study.

Table 1. Width of the anaesthetized field obtained by the employed techniques

	Anaesthetized area (mean ± SD)	
	Attached gingiva (mm)	Oral mucosa (mm)
ISA	20.33 ± 11.09	21.81 ± 9.13
PDL	7.15 ± 7.81	12.22 ± 8.64
p	p<0.05	p<0.05

Table 2. Duration of anaesthesia after the employed techniques

	Duration of anaesthesia (mean ± SD)	
	pulpal (min)	soft-tissue (min)
ISA	13.21 ± 4.36	46.48 ± 15.96
PLA	6.57 ± 4.41	28.77 ± 23.10
p	p<0.05	p<0.05

Discussion

The results of this study showed that CCArtD was reliable producing complete pulpal and soft tissue anaesthesia of the upper lateral incisor after PDL and ISA injection. In our study success rates with both anaesthetic techniques, ISA and PDL, were 77.8% and 55.6% respectively, lower than in previous study[3], where success rates for ISA and PDL were 88.6% and 91.4% respectively. The objective reason for lower anaesthetic success was that we used ½ of the anaesthetic dose that Brkovic et al[3] had used in their study. Another reason for lower PDL success lies in the fact that in this study, the higher criterion for anaesthesia - the electric pulp tester - was used to determine complete pulpal anaesthesia. On the other hand, Brkovic et al[3] used level of pain during extraction as a criterion for anaesthetic success.

In the present study, duration of complete pulpal anaesthesia was significantly longer with ISA than with PDL. Since ISA is mostly localized in the alveolar bone compared with PDL anaesthesia, and a fact that articaine diffuses well through the alveolar bone[11], it is likely the reason for longer duration of ISA pulpal anaesthesia. On the other hand, duration of PDL and ISA pulpal anaesthesia was longer (30 to 60 min) in studies where anaesthesia was obtained by high pressure injection technique[9,18].

The width of anaesthesia in the region of attached gingiva and oral mucosa in the mesio-distal direction, after the ISA, was significantly greater in comparison to PDL. It could be realized with better spreading of anaesthetic solution with ISA in comparison to PDL. It is interesting to note that the width of anaesthetized gingiva and oral mucosa after the ISA and PDL was similar with results obtained with high pressure injection technique[3,18], most likely because both techniques enable identical spreading of anaesthetics through these tissues.

Concerning local side effects, we did not obtained any. On the other hand, it is known that postoperative sensitivity to biting is usualy related to the PDL using high pressure injection[11]. White et al[20] found that 36% of the subjects reported that their teeth felt high in occlusion on the first postinjection day. None of our volunteers felt similar discomfort, and it could be explained by using CCLADS instead of high pressure syringes, most probable because the spread of local anaesthetic is equal within the tissue, while anaesthetic applied with high pressure injection could produces acute disturbance of periodontal tissue[11].

In conclusion, results of the present study showed that ISA provides successful pulpal anaesthesia of upper lateral incisors and adequate soft tissue anaesthesia in the region at least in concentrations of articaine we used.

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