



Comparative clinical evaluation of two different techniques of local anaesthesia in the posterior mandible using 4% articaine with 1 : 100,000 adrenaline

Uporedna klinička procena dve tehnike lokalne anestezije u bočnom segmentu mandibule primenom 4% artikaina sa 1 : 100 000 adrenalinom

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Abstract

Background/Aim. Local infiltration anaesthesia (LIA) is significantly simpler compared to the inferior alveolar nerve block (IAB) and less unpleasant for patients. However, it is not efficient if used in posterior region of the mandible, at least with traditional local anaesthetics. The aim of this study was to compare anaesthetic efficacy of two techniques the LIA in the posterior segment of the mandible, and the IAB, using 4% articaine with 1 : 100,000 adrenaline and to note possible changes in haemodynamic parameters caused by these two techniques. **Methods.** Sixty pre-informed patients were divided into two study groups. Both groups received 1.8 mL of the same anaesthetic solution, 4% articaine with adrenaline 1 : 100,000, with two different techniques of local anaesthesia. The first group received the LIA in projection of root apex of the first lower molar; the second group received the IAB. The examined parameters were: changes in tooth sensitivity after 5 and 30 minutes in relation to the value recorded before administering the anaesthetics, onset of anaesthesia, width of anaesthetic field, and

duration of anaesthesia. Also, the impact of the applied techniques on cardiovascular parameters was noticed. **Results.** The LIA group had a statistically significant decrease in sensitivity 5 minutes after application of the local anaesthetic. The decreasing trend continued between 5 and 30 minutes, although without statistical significance. There was no statistically significant difference in sensitivity changes between two groups for the first molar and the first and second premolars. However, there was a statistically significant difference in duration of local anaesthesia in favour of the IAB, while the width of anaesthetic fields was significantly higher after the LIA. Significant changes in hemodynamic parameters were not recorded within the two groups. **Conclusion.** The effect of the LIA on tooth sensitivity of premolars and first molar is quite satisfactory. The IAB was more effective for canine and second molar. None of the tested techniques had any significant effect on the cardiovascular parameters.

Key words:
anesthesia, dental; articaine; epinephrine; mandible.

Apstrakt

Uvod/Cilj. Lokalna infiltraciona anestezija (LIA) mnogo je jednostavnija u poređenju sa mandibularnom alveolarnom blok anestezijom (MA), a i prijatnija je za pacijente. Međutim, ona nije efikasna ukoliko se daje u posteriorni deo mandibule korišćenjem tradicionalnih lokalnih anestetika. Cilj istraživanja bio je da se uporedi efikasnost dve tehnike anestezije, LIA u bočnom segmentu mandibule, i mandibularne anestezije primenom 4% artikaina sa 1 : 100 000 adrenalina, i uoče eventualne promene hemodinamskih parametara koje ove tehnike mogu da prouzrokuju. **Metode.** Šezdeset prethodno informisanih pacije-

nata bilo je podeljeno u dve studijske grupe. Obe grupe su dobile 1,8 mL istog anestetika, 4% artikain sa adrenalinom 1 : 100 000, primenom dve tehnike anestezije. Prva grupa ispitanika primila je lokalnu infiltracionu anesteziju u projekciji vrhova korenova prvog donjeg molara. Druga grupa ispitanika primila je mandibularnu anesteziju. Ispitivani parametri bili su: promene u osetljivosti zuba nakon pet i 30 minuta u odnosu na vrednosti zabeležene pre davanja anestetika, početak dejstva anestezije, širina anestetičkog polja i trajanje anestezije. Takođe, zabeležen je i uticaj primenjenih tehnika na kardiovaskularne parametre. **Rezultati.** Grupa ispitanika LIA imala je statistički značajno smanjenje osetljivosti zuba pet minuta nakon primene LIA.

Trend smanjenja postojao je i dalje, između pet i 30 minuta, iako bez statističke značajnosti. Nije bilo statistički značajne razlike u promenama osetljivosti između dve grupe na prvom molaru i prvom i drugom premolaru. Postojala je statistički značajna razlika u trajanju anestezije u korist MA, dok je širina anestezijskog polja bila značajno veća u LIA grupi. Klinički značajne promene hemodinamskih parametara nisu zabeležene ni u jednoj studijskoj grupi. **Zaključak.** Učinak LIA bio je

zadovoljavajući kada su u pitanju premolari i prvi molar. Za anesteziju očajnika i drugog molara uspešnija je bila MA. Nijedna od ispitivanih tehnika nije imala značajan uticaj na kardiovaskularne parametare.

Ključne reči:
anestezija, stomatološka; artikain; adrenalin; mandibula.

Introduction

Although local anaesthesia is very often used in modern dentistry, it is not always successful, especially when the inferior alveolar nerve block (IAB) is concerned¹⁻³. Poor technique is not the only reason for the failure of the IAB; among others, the anatomic variations of the position of the mandibular foramen could be an additional one^{4,5}. Therefore, there is a tendency to minimize the need for the IAB, even more due to possible side-effects and complications related to it, such as injury of medial pterygoid muscle and blood vessels in the pterygomandibular space⁶.

The local infiltration anaesthesia (LIA) is significantly simpler compared to the IAB and less unpleasant for patients. However, it is not efficient if used in posterior region of the mandible, at least with traditional local anaesthetics. Articaine hydrochloride is a local anaesthetic of the amide type, introduced in Switzerland and Germany in the mid-seventies, in the US in 2000 and in Australia in 2004⁷. The specificity is that, instead of benzene, it contains a thiophene ring that allows it high lipid solubility⁸. Additionally, increased lipid solubility provides the enhanced diffusion through hard and soft tissues. This feature enables the passage of the anaesthetic even through compact posterior mandible, enabling a similar analgesic effect when infiltrating locally as it is after the IAB^{9,10}. It was confirmed that articaine achieved effective analgesia compared with lidocaine when applied in the lateral region of the lower jaw^{11,12}. However, it is not known yet whether the level of anaesthesia achieved by infiltration of local anaesthetic in the lower jaw is adequate for use in oral surgery or endodontics.

Electric pulp test (EPT) is a commonly used method for testing the vitality and sensitivity of teeth. Today, electric pulp testers (EPTs) have rheostat which adjusts the intensity of the current applied to the tooth. They vary in scale from 1–9, 1–15, 1–80¹³. Grossman¹⁴ recommended EPT for clinical purposes to check the quality of anaesthesia prior to commencement of the intervention on the teeth^{14,15}.

The aim of this study was to compare anaesthetic efficacy of two techniques, the LIA in the posterior segment of the mandible, and the IAB, using 4% articaine with 1 : 100,000 adrenaline, as well as to note possible differences in haemodynamic parameters caused by these two techniques.

Methods

This prospective randomised clinical study was conducted at the Clinic of Oral Surgery, Faculty of Dental Medicine, University of Belgrade, Serbia. The study was approved

by the Ethics Committee of the School of Dental Medicine (no. 36/19 of the 3rd of June 2015), and all participants gave written consent. The study was carried out on systemically healthy persons (ASA I) who had more than one vital teeth on the test side of the lower jaw, without large carious lesions or fillings. In total, 60 patients who participated in the study, aged between 18 to 50 years, were divided into two groups of 30 participants each – the LIA group, with participants who received the LIA in the projection of roots apices of the first lower molar and the IAB group with participants who received the regular IAB block. All participant received 1.8 mL of articaine hydrochloride (40 mg/mL) with 1 : 100000 epinephrine (SEPTANEST, Septodont, France). One researcher carried out administration of anaesthesia while another one did the measurements.

After infiltrating the anaesthetic, following parameters were examined: onset of anaesthesia determined by loss of sensation, changes in teeth sensitivity determined by EPT, duration of anaesthesia, width of anaesthetic field and possible changes of cardiovascular parameters (systolic and diastolic blood pressure and heart rate).

As the most reliable indicator of analgesia, EPT was carried out before applying anaesthetic, and then after 5, and 30 minutes. A digital tester, which produces a direct electric current, was directed to the probe touching the examined tooth, was used. The examined tooth was firstly dried with sterile gauze and air, then isolated from the adjacent teeth with celluloid strips, while the probe tip was coated with alcohol to increase the conductivity of impulses to the tooth surface. Before applying anaesthesia, sensitivity of canine, and both premolars, the first and the second, were determined. Following administration of the anaesthetic solution, the teeth that did not respond to the EPT were given a value of ten in the research record.

Width of the anaesthetic field in the LIA group of participants was tested in the area of buccal gingiva with the “pinprick” method, using a sterile dental probe 15 minutes after the application of anaesthetic. The width of the field was expressed in millimetres.

Hemodynamic parameters in both groups were monitored at various time intervals: before anaesthesia, during administration of anaesthesia, and 5, 10, 15 and 30 minutes after the administration of anaesthetics.

Statistical analysis was performed using the computer program IBM SPSS Statistics for Window software (version 20.0, IBM Corp., Armonk, NY, USA). The research results are presented in the form of mean values and standard deviations. Differences in characteristics of the achieved anaesthe-

sia between groups were determined by Student's *t*-test and Mann-Whitney U-test. For comparisons within groups, among observed three time measurements, Friedman's test was used for non-parametric data and factor analysis of variance with repeated measures (RM ANOVA) for parametric parameters. Hemodynamic parameters were analysed by ANOVA for repeated measures (Two Way RM ANOVA). To compare the two measurement points, within each of the studied groups, the Wilcoxon's test for related samples was used. *P* values less than 0.05 were considered statistically significant.

Results

Demographic characteristics of all participants are presented in Table 1, showing that both groups did not differ significantly and were comparable.

By analysing parameters of the achieved local anaesthesia, a statistically significant difference in the duration of anaesthesia was noted in favour of the IAB, whereas the width of anaesthetic field was significantly higher when administering the LIA (Table 2).

The results of tooth sensitivity, noticed by use of the EPT, are shown in Table 3 for each of the tooth tested separately. Tooth sensitivity was significantly reduced 5 minutes after application of the IAB, continuing till the end of the observing period (30 min). In the LIA group, a statistically significant reduction in sensitivity was observed within the first 5 minutes ($p = 0.001$). Also, the trend of decreased sensitivity was recorded till thirty minutes ended, indicating effective anaesthesia and the observed differences were not statistically significant.

Tooth sensibility measured 5 and 30 minutes after administration of anaesthesia, regardless of the technique of anaesthesia (the LIA vs IAB), did not differ significantly when both premolars and molars were considered. However, tooth sensibility was statistically different before and after anaesthesia in the whole investigated segment of the posterior mandible.

Haemodynamic parameters (systolic pressure, diastolic pressure and heart rate) among participants of both study groups were relatively similar, without statistically significant differences (Figure 1). The most prominent difference was noted in heart rate (Figure 1c), although it was still considered insignificant when both groups were compared.

Discussion

Although the IAB is a local anaesthesia technique of choice for interventions on lower premolars and molars, complete pulp anaesthesia of these teeth is not always achieved^{16,17}. Buccal infiltration of local anaesthetic is ineffective due to the presence of dense cortical bone which prevents adequate diffusion of the solution¹⁸⁻²⁰.

Available literature indicates that articaine with adrenaline provides similar anaesthetic effect as other amide local anaesthetics with vasoconstrictors¹⁶. Articaine is the only amide local anaesthetic that contains a thiophene ring

that gives it a distinct liposolubility. This property improves penetration of anaesthetic through the lipid membrane of neurons and the surrounding tissues^{16,21}. Kanaa et al.¹² have already demonstrated that articaine is more effective than lidocaine when applied with the LIA in the posterior mandible. Interestingly, the same authors presented later that in the upper jaw, there was no statistically significant difference in the efficiency of these two anaesthetics²². Robertson et al.²³ recorded a successful analgesia with articaine administered via LIA from 75% to 92%, which was significantly higher when compared to lidocaine. Even more, supplemental local infiltration with articaine after IAB with lidocaine provided better pulp anaesthesia of lower posterior teeth, enabling longer duration of pulp anaesthesia of the first molar and second premolar²⁴.

In this study, both techniques (LIA and IAB), articaine proved to be highly successful, in the region of the first molars and both premolars. In other words, there was no statistically significant difference between the two groups, although this difference between the two techniques was noticed on the second molar and canine. The reasons for this may be the individual anatomical nature, such as the increased thickness of the buccal lamella in the region of the second molar, more lingual position of the mandibular canal, as well as the fact that the anaesthetic was applied proximal to the mentioned tooth. Haas et al.²⁵ reported that there was no difference in achieving pulp anaesthesia in mandibular teeth between 4% articaine and 4% prilocaine, both with adrenaline 1 : 200,000. When it comes to the second lower molar, they noted the success in achieving the pulp anaesthesia after LIA in 63% (12/19) of patients when articaine was used, and 53% (10/19) after 4% prilocaine. Their results support the fact that the buccal lamella is wider in the region of the second molar, and indicate that articaine diffuses better through the compact bone, as the results of the present study show. Results of this research indicate that the anaesthetic effect is similar to both anaesthesia techniques and correspond with results of clinical studies testing the efficacy of articaine applied with the LIA in the lower jaw. Poorni et al.¹¹ compared the LIA and IAB applying articaine and lidocaine in patients with irreversible pulpitis of lower molars. That study included participants with the present pain caused by the pulp disease, which was a basic measure in assessing the efficacy of two experimental techniques and local anaesthetics. The success of achieved anaesthesia was evaluated on the basis of achieving painlessness in access preparation and pulp extirpation, and the authors concluded that there was no difference.

The amount of the applied solution, can also have effect on the quality of the achieved anaesthesia. In this study, all patients received 1.8 mL of articaine/adrenaline. Applying twice the dosage with the LIA, a higher degree of success could be expected, as shown in the study by Martin et al.²⁶.

Most of the literal data is related to the achievements by using the pulp anaesthesia for removing pain in irreversible pulpitis. Measuring the success of anaesthesia refers to the percentage of patients in whom the absence of reaction to the maximum pulp test stimulation in two consecutive measurements was achieved. It should be noted that the EPT

Table 1

Demographic characteristics of participants			
Characteristics of participants	MBA	ILA	Total
Gender			
male	10	15	25
female	20	15	35
Total	30	30	60
Age (years), $\bar{x} \pm SD$	24.73 \pm 4.86	27.20 \pm 5.68 *	

MBA – mandibular block anaesthesia; ILA – infiltration local anaesthesia;
 \bar{x} – arithmetic mean; SD – standard deviation; * – Students's *t*-test, $p = 0.076$.

Table 2

Anaesthesia technique characteristics		
Parameters	MBA	ILA
	$\bar{x} \pm SD$, (median)	$\bar{x} \pm SD$, (median)
Time to onset of anaesthesia (min)	1.93 \pm 0.79, 2.0*	1.77 \pm 0.73, 2.0
Duration of anaesthesia (min)	334.63 \pm 98.59, 351.00**	214.7 \pm 47.78, 205.00
Width of anaesthetic field (mm)	39.43 \pm 17.54, 35.50	57.27 \pm 9.16, 53.50***

\bar{x} – arithmetic mean; SD – standard deviation; * – Mann-Whitney *U*-test, $p = 0.379$;
 ** – Students's *t*-test, $p = 0.01$; *** – Students's *t*-test $p = 0.001$.

Table 3

Influence of mandibular block anaesthesia (MBA) and local infiltration anaesthesia (LIA) on tooth sensitivity estimated by electric pulp testing (EPT)

Tooth	Before anaesthesia	Time of EPT 5 min after	30 min after	<i>p</i>
Second molar				
MBA	3.17 \pm 1.4	7.97 \pm 3	9.27 \pm 1.7	0.000 (a, a ₁ , a ₂) 0.011 (a ₃)
LIA	2.4 \pm 0.9	6.27 \pm 3	6.23 \pm 2.8	0.000 (b, b ₁ , b ₂) 0.932 (b ₃)
<i>p</i> *	0.023	0.019	0.000	
First molar				
MBA	3.17 \pm 1.9	7.58 \pm 2.4	9.08 \pm 1.4	0.000 (a, a ₁ , a ₂) 0.004 (a ₃)
LIA	2.64 \pm 1.3	6.84 \pm 3	6.88 \pm 3.1	0.000 (a, a ₄ , a ₅) 0.886 (a ₆)
<i>p</i> *	0.318	0.410	0.017	
Second premolar				
MBA	3.2 \pm 1.2	8.13 \pm 2.4	9.6 \pm 1.2	0.000 (a, a ₁ , a ₂) 0.001 (a ₃)
LIA	2.55 \pm 1.2	8.24 \pm 2.7	8.52 \pm 2.5	0.000 (b, b ₁ , b ₂) 0.449 (b ₃)
<i>p</i> *	0.011	0.652	0.135	
First premolar				
MBA	3.14 \pm 1.2	7.83 \pm 2.8	9.66 \pm 0.9	0.000 (a, a ₁ , a ₂) 0.004 (a ₃)
LIA	2.48 \pm 0.9	7.62 \pm 2.9	8.55 \pm 2.6	0.000 (a, a ₄ , a ₅) 0.147 (a ₆)
<i>p</i> *	0.001	0.681	0.086	
Canine				
MBA	3.640 \pm 1.8	7.93 \pm 2.9	9.82 \pm 2.5	0.000 (a, a ₁ , a ₂) 0.007 (a ₃)
LIA	2.8 \pm 1.1	5.13 \pm 3	6.07 \pm 3.4	0.000 (a, a ₄ , a ₅) 0.096 (a ₆)
<i>p</i> *	0.057	0.001	0.000	

*Mann-Whitney test;

a₁, a₄, b₁ – comparing before and 5 min after anaesthesia

a₂, a₅, b₂ – comparing before and 30 min after anaesthesia

a₃, a₆, b₃ – comparing before and 5 min and 30 min after anaesthesia.

Second molar: ^aFriedman's test; ^{a1, 2, 3}RM ANPVA, ^{a1, 2, 3} – Wilcoxon Signed Ranks test; ^{b1, b2, b3} – Paired simple *t*-test;

First molar: ^aRM ANPVA; ^{a1, 2, 3, 4, 5, 6} – Paired simple *t*-test;

Second premolar: ^aRM ANPVA; ^bFriedman's test; ^{a1, 2, 3} – Paired simple *t*-test; ^{b1, 2, 3} Wilcoxon Signed Ranks test;

First premolar: ^aFriedman's test; ^{a1, 2, 3, 4, 5, 6} Wilcoxon Signed Ranks test;

Canine: *Mann-Whitney test; ^aFriedman's test; ^{a1, 2, 3, 4, 5, 6} Wilcoxon Signed Ranks test; ^{a1, 4} – comparing before and 5 min after anaesthesia applied; ^{a2, 5} – comparing before and 30 min after anaesthesia applied; ^{a3, 6} – comparing 5 and 30 min after anaesthesia applied.

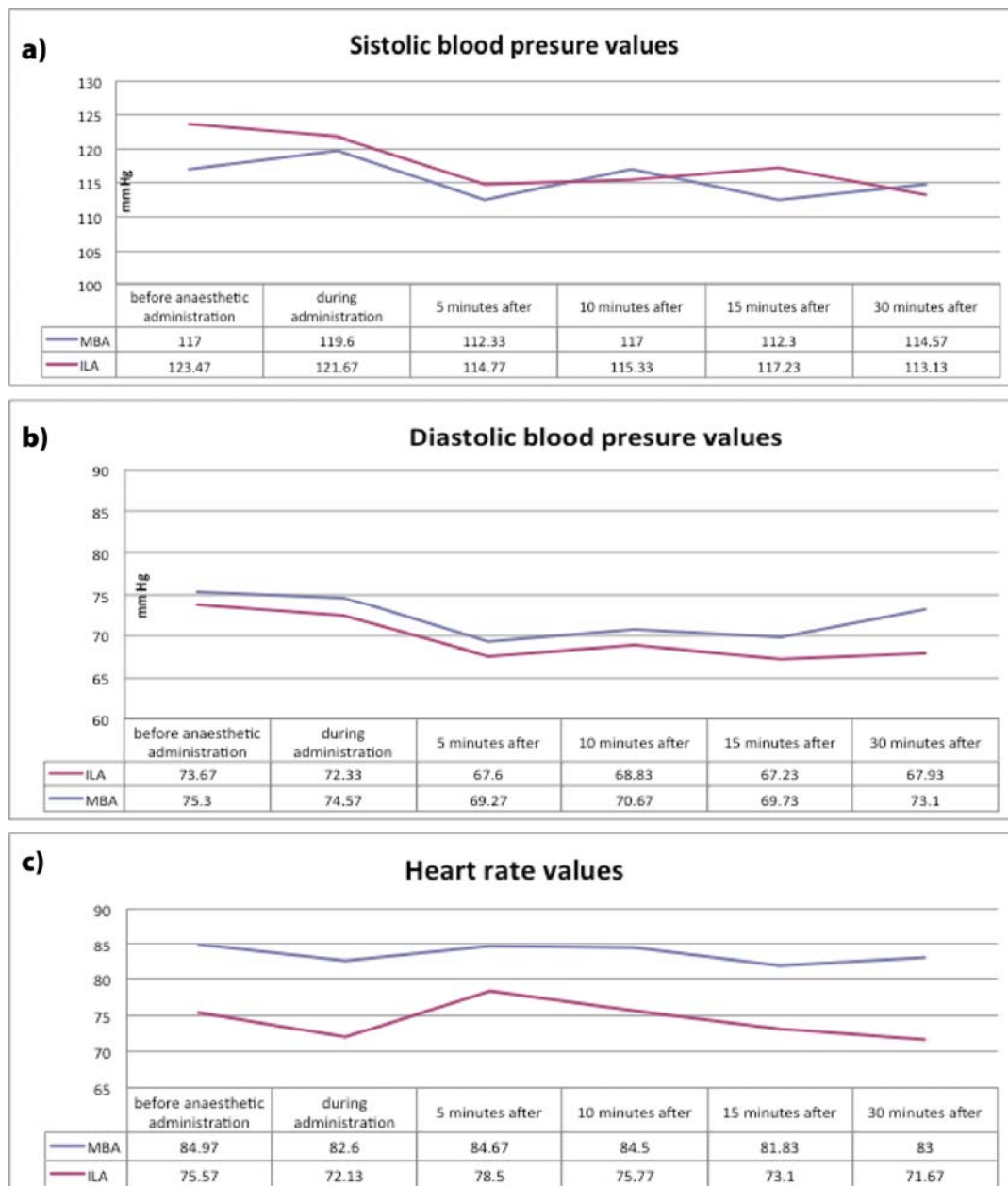


Fig. 1 – Influence of infiltration local anaesthesia (ILA) and mandibular block anaesthesia (MBA) on haemodynamic parameters over observation time period:

- Systolic blood pressure changes: values were statistically significantly different over time and among different time intervals in each of the study groups ($p = 0.001$; $p = 0.017$), but with no statistically significant difference between the two groups;**
- Diastolic blood pressure changes: there was a statistically significant difference during various time intervals in each of the study groups ($p < 0.001$), whereas the difference in the values of diastolic blood pressure between the two groups was not statistically significant ($p = 0.532$);**
- Heart rate changes: heart rate was also significantly changed over time intervals in both groups ($p = 0.001$), whereas no statistically significant difference between the two different groups was observed ($p = 0.258$).**

technique is not a quantitative indicator of the pulp sensitivity^{27, 28}. Mental condition of the patient during the day or at different time intervals has an impact on the reliability of testing tooth sensitivity²⁹.

To the best of our knowledge, there were no previous studies that compared anaesthetic and cardiovascular effects of articaine administered with the LIA and IAB, respectively. Differences in cardiovascular parameters between patients of

the LIA and IAB groups were statistically insignificant; it seems that both techniques of anaesthesia are clinically safe for risk patients.

Onset of anaesthesia in our study was slightly shorter in the LIA group, but with no statistical significance.

Duration of anaesthesia after the IAB was significantly longer than that provoked by the LIA, which was expected. This fact is of clinical importance. On one hand, long-term

anaesthesia after administration of the IAB would provide long-lasting analgesia after the intervention in which severe postoperative pain could be expected (for example after oral surgery). On the other hand, in contrast to this, in interventions with smaller or non-existent postoperative pain, the use of the LIA with articaine can avoid unpleasant long-term numbness.

Width of anaesthetic field measured with "pin prick" test was significantly higher after the LIA technique, due to simultaneously achieved buccal nerve anaesthesia; the LIA did not have simultaneous lingual nerve anaesthesia, which the IAB did.

Conclusion

The effect of the LIA on tooth sensitivity of premolars and first molar was quite satisfactory. The IAB was more effective for canine and second molar. None of the tested techniques had any significant effect on the cardiovascular parameters.

Conflict of interest

The authors declare that they have no conflict of interest.

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