บทวิทยาการ
Original Article

ผลของการฉีดยายับยั้งเส้นประสาทขากรรไกรล่างด้วยยาชาอาร์ติเคน 4 เปอร์เซ็นต์ผสมอิพิเนฟริน 1:100,000 ต่อสัญญาณการไหลเวียนโลหิตของเนื้อเยื่อในด้วยเครื่องมือเลเซอร์ดอปเปลอร์

Effects of Mandibular Nerve Block with 4% Articaine with Epinephrine 1:100,000 on Pulpal Blood Flow Signals Recorded by Laser Doppler Flow-meter

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาผลของการฉีดยาระงับเส้นประสาทขากรรไกรล่างด้วย อาร์ติเคน 4% ที่มีอิพิเนฟรินผสม 1:100,000 ต่อการไหลเวียนเลือดระดับจุลภาคของเนื้อเยื่อในฟัน โดยบันทึกการเปลี่ยนแปลงด้วยเครื่องเลเซอร์ดอปเปลอร์ โฟลว์มิเตอร์

วัสดุอุปกรณ์และวิธีการศึกษา: การศึกษานี้ผ่านการรับรองจากคณะกรรมการพิทักษ์สิทธิ์ คณะทันตแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ การทดลอง

Abstract

Objective: The aim of this study was to investigate the effects of mandibular nerve block with 4% articaine with epinephrine 1:100,000 on pulpal microcirculation recorded by laser Doppler flow-meter in vivo.

Materials and methods: This study was approved by the Human Experimentation Committee of the Faculty of Dentistry, Chiang Mai

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ถูกทำขึ้นเป็นส่วนหนึ่งของการรักษาด้วยการทำสะพานฟันชนิดโลหะเคลือบพอร์ซเลน 3 ยูนิต ทดแทนฟันกรามซี่ที่หนึ่งล่าง ในอาสาสมัครจำนวน 16 ราย (อายุ 18-25 ปี) โดยฟันหลักทั้งสองซี่จะต้องเป็นฟันที่มีชีวิตและมีสภาพสมบูรณ์ การเตรียมฟันหลักทำภายใต้การฉีดยาชาเฉพาะที่ด้วยอาร์ติเคน 4% ที่มีอิพิเนฟริน 1:100,000 ผสมอยู่ วัดอัตราการไหลเวียนเลือดระดับจุลภาคด้วยเครื่องเลเซอร์ดอปเปลอร์โดยวางโพรบที่บริเวณกึ่งกลางด้านแก้มของฟันกรามน้อยซี่ที่สองและฟันกรามซี่ที่สอง ใส่เฝือกพลาสติกทึบแสงชนิดทำขึ้นเองเพื่อช่วยวางตำแหน่งของโพรบและลดแสงสะท้อนที่ไม่ต้องการจากเนื้อเยื่อเหงือก บันทึกสัญญาณการไหลเวียนเลือดก่อน และวัดซ้ำ 5 นาทีหลังการฉีดยาระงับเส้นประสาทขากรรไกรล่าง สัญญาณออกจะถูกแปลงและบันทึกเข้าคอมพิวเตอร์เพื่อประมวลผลต่อไป

ผลการศึกษา: ค่ามัธยฐานของการไหลเวียนของเลือดของเนื้อเยื่อในที่วัดภายหลังการฉีดยาระงับเส้นประสาทขากรรไกรล่าง 5 นาทีด้วย อาร์ติเคน 4% ที่มีอิพิเนฟริน 1:100,000 ผสมอยู่ ของฟันกรามน้อยซี่ที่สอง และฟันกรามซี่ที่สองมีค่าลดลงอย่างมีนัยสำคัญ 21.46 และ 19.78 เปอร์เซ็นต์ตามลำดับ ค่า *p* น้อยกว่า 0.05 จึงจะถูกพิจารณาว่ามีความแตกต่างกันอย่างมีนัยสำคัญ

บทสรุป: การฉีดยาระงับเส้นประสาทขากรรไกรล่างด้วย อาร์ติเคน 4% ผสมอิพิเนฟริน 1:100,000 ทำให้การไหลเวียนของเลือดของเนื้อเยื่อในลดลงอย่างมีนัยสำคัญ

คำสำคัญ: ยาชาเฉพาะที่ เครื่องมือเลเซอร์ดอปเปลอร์ การไหลเวียนเลือดของเนื้อเยื่อใน

University. The experiment was performed as a part of a three-unit full-coverage porcelain-fused-to-metal bridge treatment to replace a lost permanent mandibular first molar in sixteen volunteers (aged 18-25 years old). The vital and intact abutments were prepared under local anesthesia with 4% articaine with epinephrine 1: 100,000. Pulpal microcirculation was recorded using a laser Doppler flow-meter, by placing the fiber optic probe at the middle of the buccal surface of the second premolar and second molar teeth. Custom-made opaque plastic splints were used to position and to stabilize the probe and to minimize undesirable reflected light from the gingival tissues. The measurements were made before, and repeated five minutes after, a mandibular nerve block. The output signals were digitalized and fed into a lap-top computer for later analysis.

Results: The medians of pulpal blood flow signals (measured five minutes after mandibular nerve block with 4% articaine with 1:100.000 epinephrine of both premolars and molars) showed significant reduction (21.46% and 19.78%, respectively), compared to the pre-block measurements. The *p* values less than 0.05 was considered significant difference.

Conclusions: The mandibular nerve block with 4% articaine with 1:100.000 epinephrine caused significant reduction in pulpal blood flow signals.

Keywords: Local anesthesia, laser Doppler flow-meter, pulpal blood flow

Introduction

The vital tooth is supplied with a micro-circulation system, which responds to the surrounding environment and to external stimuli, especially when dentin is exposed. Increased or decreased pulpal blood flow promotes a change in intrapulpal pressure that causes dentinal fluid to flow outward or inward through the exposed dentin[1,2]. These fluid flows can have an effect on the bond strength of restorative materials, such as bonding agents and dental cements. The tensile bond strengths of glass-ionomer cements in vital teeth, which have outward flow of dentinal fluid, are weaker than those in non-vital teeth[3]. Significant reduction in the bond strength of hydrophobic self-etch adhesives has also been reported when the intrapulpal pressure was set[4].

Dental procedures may also effect the pulpal circulation. Local anesthetic solutions, such as lidocaine, articaine, mepivacaine and prilocaine are an important part of daily routine treatment in dental practice. Currently available local anesthetics possess a certain degree of vasoactivity. Most local anesthetics used in dental practice reduce vascular tone, an effect called vasodilatation, which may cause an increase in blood flow to the injection site[5]. Plain prilocaine and plain mepivacaine have no vascular effect[6,7], while other anesthetic solutions, such as plain solutions of lidocaine or articaine can induce some degree of vasodilatation[6]. However, most local anesthetics for dental use contain vasoconstrictor to prolong their effect.

In general, vasoconstrictors, such as epinephrine, norepinephrine and levonordefrin, are added to local anesthetics to gain several benefits, such as a decrease in the peak plasma concentration of the local anesthetic agent, an increase in the duration and the quality of anesthesia, a reduction of the minimum concentration of anesthetic needed for nerve block, and a decrease in blood loss during surgical procedures[5,8-10]. The concentration of vasoconstrictors in local anesthetics available in the market, ranges from 1:50,000 to 1:300,000[11].

Least is known about the vascular effects in the human dental pulp of widely used local anesthetics containing vasoconstrictors. The objective of this study was to investigate the effects of mandibular nerve block with 4% articaine with epinephrine on pulpal microcirculation recorded by laser Doppler flow-meter in vivo.

Materials and methods

The study was approved from the Human Experimentation Committee of the Faculty of Dentistry, Chiang Mai University, Chiang Mai, Thailand IRB No.32/2008. All participants were provided with a complete explanation of this experiment before written informed consent was obtained.

Sixteen healthy subjects (the age of subjects was between 18 and 25 years old), who had lost a permanent mandibular first molar and required a fixed dental prosthesis, voluntarily participated in this project. A medical history was taken from all subjects to ensure that they had no history of allergic reaction to articaine or epinephrine, used in this study. The premolar and molar abutments were vital and had no decay and shallow restorations not exceeding 0.5 mm in depth.

Both abutment teeth were anesthetized by the inferior alveolar nerve block technique using 0.9 ml of 4% articaine with 1:100,000 epinephrine (UbistesinTM Forte, 3M ESPE, Seefeld, Germany) with an additional 0.8 ml for a lingual nerve block.

Careful aspiration before injection was performed in every subject to reduce the risks of intravascular injection of both local anesthetic and vasoconstrictor.

The pulpal blood flow data for both abutments were recorded by a Moor-type MBF3D laser Doppler flow-meter (Moor Instruments Ltd, Axminster, Devon, UK; wavelength, 780-820 nm). A custom-made opaque acrylic stent was fabricated for each subject. It was fitted on the buccal surface of the abutments, extending from the first premolar to the second or third molar to prevent contamination signals from the gingiva and to stabilize the LDF probe to minimize movement artifacts, and for accurate repositioning of the probe for repeat measurements. The laser probe (1.5 mm external diameter and containing two optical fibers of diameter 0.2 mm that were 0.5 mm apart at the tip) was placed perpendicularly to the buccal tooth surface at the level of 2 mm above the gingival margin.

Pulpal blood flow records were obtained before, and five minutes after, local anesthetic injection. The LDF signal was monitored for at least 20 seconds. Two sets of data (before and after) were obtained from both premolar and molar abutments. The analog signal output from the laser Doppler flow-meter was digitized using a CED 1401 data acquisition unit (Cambridge Electronic Design Limited, Cambridge, UK) and was stored in a lap-top computer for later analysis.

After the recording procedure, the standard procedures for preparing the full-coverage three-unit porcelain fused-to-metal bridge abutment were performed using an air-rotor handpiece with sufficient water-cooling for crown preparation. A temporary bridge was fixed at the end of the visit and the permanent bridge was inserted one week later.

During the experiment, all subjects were laid in a comfortably supine position on the dental chair. The temperature of the room was controlled at 25 degrees Celsius by an air conditioner. All procedures were performed by a single operator using the same air rotor handpiece, dental chair position and operation room.

The median values of pulpal blood flow signals, recorded before and five minutes after mandibular nerve block injection, in both abutments were compared using the Wilcoxon signed rank test using statistical software (Sigmastat®, Systat Software Inc., San Jose, California). The *p* value 0.05 was considered as a significant difference.

Results

The mandibular nerve block injection with 4% articaine with epinephrine 1:100,000 caused a significant reduction in pulpal blood flow signals recorded from both abutments compared to the baseline values (Figure 1). The median values and semi-interquartile range for both permanent mandibular second premolar and permanent mandibular second molar teeth are presented in Table 1. The blood flow signals from both abutments were reduced by 21.46% from 42.07 AU and 19.78% from 53.83 AU, respectively.

Table 1. *Medians and semi-interquartile ranges of flow signals of pulpal blood flow obtained from both mandibular second premolar and mandibular second molar abutments before and after local anesthetic injection.*

	Second Premolar (median, semi-interquartile)	**Second Molar (median, semi-interquartile)**
Before injection	42.07, 28.24	53.83, 30.84
After injection	33.04, 23.90	43.18, 27.04

*There was a statistically significant difference at P<0.05.

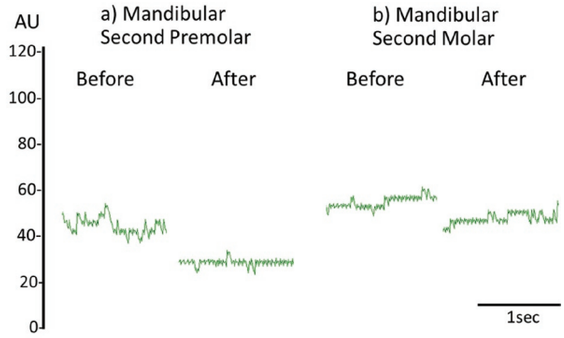

Figure 1. *Representative pulpal blood flow signals recorded before and after local anesthetic injection from (a) mandibular second premolar and (b) mandibular second molar abutment teeth.*

Discussion

The study revealed that the injection of 4% articaine with epinephrine 1: 100,000 reduced pulpal blood flow, a result which resembles that of Panopoulos[12] and those of other studies which used different types of anesthesia and different injection techniques[11,13,14].

The reduction of pulpal blood flow that followed the local anesthetic injection of 4% articaine with 1:100,000 epinephrine in this study is likely to be the effect of the vasoconstrictor. Our results correspond with those of other studies[11,15]. But the results of a study by Elad and Colleagues revealed that there were no significant changes in blood pressure or heart rate[16]. Moreover, epinephrine may result in elevation of the mean systolic blood pressure and heart rate[17].

Vasoconstrictor in local anesthetic injection causes a reduction of the vessel diameter as an action of epinephrine on the smooth muscle of the arteries, causing vasoconstriction. A decrease in diameter of the supplied vessels would result in a significant reduction in pulpal blood flow.

Our experiment found that the pulpal blood flow in both premolar and molar abutments was reduced significantly after injection of a local anesthetic with epinephrine. This result is similar to the results of other studies[9,13,18,19]. The reduction of pulpal blood flow was due to the depression of nerve activity responses to epinephrine[20]. This reduction of pulpal blood flow in abutment teeth may lead to aggregation of irritants (from the abutment preparation), which diffuse into the dentine and may be harmful to the dental pulp.

Many studies have found no significant changes in either blood pressure or heart rate[21,22]. Nevertheless, some authors have suggested that such changes depend on the dose of vasoconstrictor in the anesthetic injection[5,9,23]. Therefore, the selection of the anesthetic solution is primarily based on the treatment procedure period. Since the removal of the pulpal concentration of toxic substances depends on the rate of removal via the pulpal microcirculation. Therefore, a significant reduction in pulpal blood flow from a local anesthetic could lead to a high concentration of the irritants.

Conclusions

The mandibular nerve block of 4% articaine with epinephrine 1:100,000 produced a reduction in pulpal blood flow recorded by laser Doppler flow-meter.

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