

การเปรียบเทียบความดันเลือดและอัตราชีพจรในผู้ป่วยที่เป็นโรคความดันเลือดสูง  
หลังจากที่ฉีดอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน  
1 : 100,000 และ 1 : 200,000

Comparison of blood pressure and pulse rate  
in hypertensive patient following the injection of  
4% articaine with epinephrine 1 : 100,000 and 1 : 200,000

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาการเปลี่ยนแปลงของความดันเลือดและอัตราชีพจรหลังจากการให้ยาชาที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 และ 1 : 200,000 ทำการเก็บข้อมูลจากผู้ป่วยโรคความดันเลือดสูงแบบควบคุมได้ทั้งหมด 60 ราย เก็บข้อมูลความดันเลือด อัตราชีพจร ความวิตกกังวลก่อนการรักษาทางทันตกรรม และค่ามาตรวัดความเจ็บปวดด้วยตัวเลข โดยความดันเลือดและอัตราชีพจรจะทำการบันทึกทั้งหมด 5 ครั้ง คือก่อนฉีดยาชา 5

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นาที (T0) หลังฉีดยาชาทันที (T1) ร่วมกับการวัดค่ามาตรฐานวัดความเจ็บปวดด้วยตัวเลข หลังฉีดยาชา 5 นาที (T2) 10 นาที (T3) และ 15 นาที (T4) ตามลำดับ เมื่อเปรียบเทียบค่าเฉลี่ยของค่าความดันเลือดซิสโตลิก ความดันเลือดไดแอสโตลิก และค่าชีพจรเทียบกับช่วงเวลาก่อนฉีดยาชา 5 นาที (T0 : baseline) ภายในแต่ละกลุ่มพบว่า ค่าเฉลี่ยของค่าความดันเลือดและอัตราการชีพจรทั้งหมดมีการเปลี่ยนแปลงมากที่สุดหลังจากการฉีดยาชาทันที (T1) เว้นแต่ค่าชีพจรของกลุ่มที่ใช้ยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 200,000 ที่มีการเปลี่ยนแปลงมากที่สุดในช่วงเวลา 5 นาทีหลังฉีดยาชา (T2) และลดลงจนใกล้เคียงค่าเริ่มต้นภายใน 15 นาที สรุปได้ว่า ค่าความดันเลือดและอัตราการชีพจรในผู้ป่วยที่เป็นโรคความดันเลือดสูงหลังฉีดยาชาอาร์ติเคน 4% ทั้ง 2 กลุ่มไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ

**คำสำคัญ:** ความดันเลือด ความดันเลือดสูง อัตราชีพจร เอพิเนฟริน

### Abstract

This research aimed to study the changes in blood pressure and pulse rate after the administration of 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine in 60 well-controlled hypertensive patients. The data collection included blood pressure, pulse rate, the numeric rating scale (NRS), and the modified dental anxiety score (MDAS). Hemodynamic parameters were recorded in 5 periods as T0 defined as 5 minutes before the injection (baseline), T1 defined as immediately after the injection along with NRS. The T2, T3, and T4 were defined as 5, 10, and 15 minutes after the injection, respectively.

Comparing mean hemodynamic parameters at different times to baseline showed that almost all parameters changed to peak level immediately after injection (T1) except pulse rate of 4% articaine with 1 : 200,000 epinephrine reached the peak at T2 then gradually decreased to baseline within 15 minutes. In conclusion, comparison of blood pressure and pulse rate in hypertensive patient following the injection of 4% articaine in both groups had no statistically significant difference in hemodynamic changes.

**Keywords:** blood pressure, epinephrine, hypertension, pulse rate

## Introduction

In the cohort study of the prevalence of hypertension in a dental university clinic with more than 3,500 individuals, 16.6% of the people were hypertensive which defined in the study as a clinic-measured systolic blood pressure (SBP) greater than 140 mmHg or a diastolic blood pressure (DBP) greater than 90 mmHg at the time of measurement. Of this group, 32.2% of the subjects having been told by a physician that they had

hypertension, whereas about 27% had no previous diagnosis of hypertension. This suggested that measuring blood pressure in the dental setting was beneficial in identifying people with undiagnosed hypertension.<sup>(1)</sup>

To understand why it was important to identify hypertensive patients before performing dental procedures, the mechanism of vascular changes must be understood first. The body reacts to psychological and physical stress such as painful stimuli, anxiety, fear, and

discomfort by releasing epinephrine and catecholamines which cause variations of vascular reactivity changes. Rapid changes in chronotropism and inotropism affect cardiac output. On the other hand, peripheral vascular resistance is influenced by alterations of vasodilation and vasoconstriction. The overall outcome of any invasive procedure that used local anesthetic agents with vasoconstrictor seems to trigger the sympathetic nervous system. Diastolic pressure is affected by fluctuations of peripheral vascular resistance whereas both cardiac output and peripheral resistance impact SBP.<sup>(2)</sup>

As a dentist, identification of increased blood pressure is important because fatal subarachnoid hemorrhage and excessive bleeding from dental surgery have been reported.<sup>(3)</sup> Another study reported that epinephrine could increase pre-existing elevated systolic blood pressure. Such an increase can cause an acute hypertensive crisis, leading to hypertensive encephalopathy, cerebral hemorrhage, and acute left ventricular failure.<sup>(4)</sup>

The following statement mentioned about local anesthetic in dental practices. Articaine is one of the most commonly used local anesthetics in dental procedures. When compared to other moderate and short-duration local anesthetic which is advocated by many authors, articaine is a local amide anesthetic that is similar to lidocaine but has superior efficacy. Articaine is common in the dentistry field due to excellent distribution throughout the bone.<sup>(5)</sup>

The addition of vasoconstrictor agents in local anesthetic contributed to many beneficial effects such as depth and duration of the anesthesia, decreasing systemic toxicity, and increasing hemostasis during surgery. Thus, the most common vasoconstrictor agent used in conjunction with articaine is epinephrine.<sup>(6,7)</sup> However, this agent has various hemodynamic effects.

Its effects lead to peripheral vasoconstriction, increased pulse constrictions, and vasodilation in muscles. Therefore, epinephrine increases blood pressure and pulse rate.<sup>(3)</sup>

Epinephrine has a potent effect on beta receptors, although both alpha and beta receptors are affected. The vasoconstrictor effect of epinephrine results from stimulating alpha-one receptors stimulation which increases pulse rate (PR) and blood pressure. Progressive administration of epinephrine at higher doses than those used in dentistry leads to increasing cardiovascular activity and oxygen consumption.<sup>(7,8)</sup>

The aim of this research was to study the alterations of blood pressure and pulse rate after the injection of 4% articaine with epinephrine 1 : 100,000 and 1 : 200,000.

## Material and methods

This prospective randomized, double-blind controlled trial. Sixty patients with controlled hypertension who were admitted to undergo for oral surgery treatment at College of Dental Medicine Rangsit University, from March to October of 2023.

The study was approved by the Ethics Review Board of Rangsit University (certificate of approval number RSUERB2023-030).

The inclusion criteria involved well-controlled hypertensive patients who were on antihypertensive medications with the maximum systolic blood pressure at 139 mmHg and diastolic blood pressure at 89 mmHg.<sup>(9)</sup> The ages were older than 18 years old. Those patients who had uncontrolled hypertension, allergic reactions to articaine or antioxidant of vasoconstriction agents (e.g. sodium metabisulfite), pregnancy or breastfeeding women, compromised immune system, or severe/uncontrolled systemic disease (ASA III or more) were excluded from this study.

When patients arrived at oral surgery clinic for dental treatment, the study's objectives and procedures were explained to all included patients for signing the informed consents. Patients were invited to the dental chair and filled up the questionnaires; modified dental anxiety scale, and demographic data about their name, age, gender, mobile phone number, and medical history.

Patients were divided randomly into two equal groups. Group one: received 1 cartridge (1.7 ml) of 4% articaine with 1 : 100,000 epinephrine and group two: received 1 cartridge (1.7 ml) of 4% articaine with 1 : 200,000 epinephrine. All procedures in the study were performed by dental students who were trained in inferior alveolar nerve block technique and infiltration technique by using the same reference.<sup>(5)</sup> All injection procedures were closely supervised by oral surgery instructor in a relaxed atmosphere with no anxiolytic medication preoperatively needed. The patient's face was covered with sterile linen. The types of anesthetics were blinded to patients and the operators.

On the dental chair in the upright position, an automatic blood pressure monitor (Omron® model no. HEM-7156-A) was applied to the left arm to measure the hemodynamic parameters, including SBP, DBP and PR. All hemodynamic parameter were recorded at 5 different times and all patients were rested before measurement 5 minutes.<sup>(10)</sup> The first measurement is defined as T0: at 5 minutes before injection, T1: immediately after administration of local anesthetic and mouth rinsing. Therefore, the NRS was marked to indicate the pain level from the injection. Then T2, T3, and T4: at 5, 10, and 15 minutes after injection respectively.

Using the automatic upper arm blood pressure monitor was as follows; firstly, prepared an automatic blood pressure monitor on the table beside the dental

unit, the patient sat in an upright position on the dental unit, adjusting the dental chair so that the patient's feet were on a flat floor and their hearts were at the same level as the automatic blood pressure monitor. Then resting quietly for 5 minutes.<sup>(11)</sup> Secondly, rest the patient's non-dominant arm on the table then supported with a pillow, which was at the same level as the patient's heart. The arm was stretched out and the palm facing upwards.

Selecting the cuff size as a bladder length that was 80% and a width that was at least 40% of the arm circumference (a length-to-width ratio of 2 : 1). Placed the cuff on an anterior aspect of the elbow, medial to the tendon of the biceps, and placed the midline of the bladder of the cuff. The lower end of the cuff should be 2 to 3 cm above the antecubital fossa. Then, pulled the end of the cuff evenly tight around the arm, the tightness of the cuff must be tight enough to allow two fingertips to slip under the top edge of the cuff. Assured that the tubing fell over the front center of the arm so that the sensor was correctly placed.

Lastly, before getting started, instruct the participants to remain still and quiet while the machine is measuring blood pressure. Wait for a moment, then press the start button on the machine.<sup>(12)</sup>

## Statistical analysis

The data of this study were collected from March to October 2023 under the approval of the ethical review committee for human research (COA No.R-SUERB2023-030). The sample size was analyzed by using the GPower 3.1.9.7 program for intraclass correlation coefficient with an alpha error of 0.05, and power of test 0.80. The Shapiro-Wilk test was performed to evaluate whether the data followed a normal distribution. The comparison of mean  $\pm$  SD of SBP, DBP and

ตารางที่ 1 อธิบายข้อมูลเชิงสถิติของกลุ่มการศึกษา (เพศและอายุ) (N = 60)

Table 1 Descriptive statistics of the study groups (gender and ages) (N = 60).

Epinephrine	N	Male (%)	Female (%)	Age (years)
1 : 100,000	30	13 (43.3)	17 (56.7)	67.7 ± 9.23
1 : 200,000	30	15 (50)	15 (50)	61.1 ± 9.51

ตารางที่ 2 ค่าเฉลี่ยและส่วนเบี่ยงเบนมาตรฐานของค่ามาตรวัดความเจ็บปวดด้วยตัวเลขและค่าความวิตกกังวล

Table 2 Mean and standard deviation of NRS and anxiety.

Epinephrine	N	NRS	Anxiety
1 : 100,000	30	1.77 ± 1.96	7.37 ± 4.14
1 : 200,000	30	1.50 ± 1.63	7.20 ± 3.14
<i>p</i> -value*		0.95	0.36

\**p*-value of NRS and anxiety evaluated from Mann-Whitney U test (*p* < 0.05)

NRS = numeric rating scale

ตารางที่ 3 เปรียบเทียบค่าความดันเลือดซิสโตลิก ความดันเลือดไดแอสโตลิก และค่าชีพจรระหว่างยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 และ 1 : 200,000 ในช่วงเวลาที่ต่างกัน

Table 3 Comparison of systolic blood pressure, diastolic blood pressure and pulse rate between 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine at different times.

Hemodynamic parameters (units of measurement)	Group	Measurement times									
		T0	<i>p</i> -value	T1	<i>p</i> -value	T2	<i>p</i> -value	T3	<i>p</i> -value	T4	<i>p</i> -value
Systolic blood pressure	1	128.3 ± 10.2	0.84	135.8 ± 13.4	0.21	130.8 ± 14.3	0.93	128.8 ± 16.3	0.62	129.1 ± 13.8	0.81
	2	127.7 ± 10.1		131.8 ± 11.0		130.6 ± 9.70		130.6 ± 10.9		128.3 ± 11.1	
Diastolic blood pressure	1	72.5 ± 8.03	0.49	75.9 ± 9.19	0.47	74.4 ± 9.55	0.32	74.2 ± 8.70	0.39	74.9 ± 8.62	0.83
	2	73.8 ± 7.16		77.2 ± 8.86		76.9 ± 10.4		76.3 ± 10.4		75.4 ± 8.92	
Pulse rate	1	80.0 ± 13.9	0.73	80.4 ± 15.3	0.33	80.2 ± 15.3	0.42	78.8 ± 14.8	0.46	78.3 ± 15.3	0.49
	2	78.8 ± 13.2		76.8 ± 12.9		77.2 ± 13.1		76.1 ± 13.4		75.7 ± 13.6	

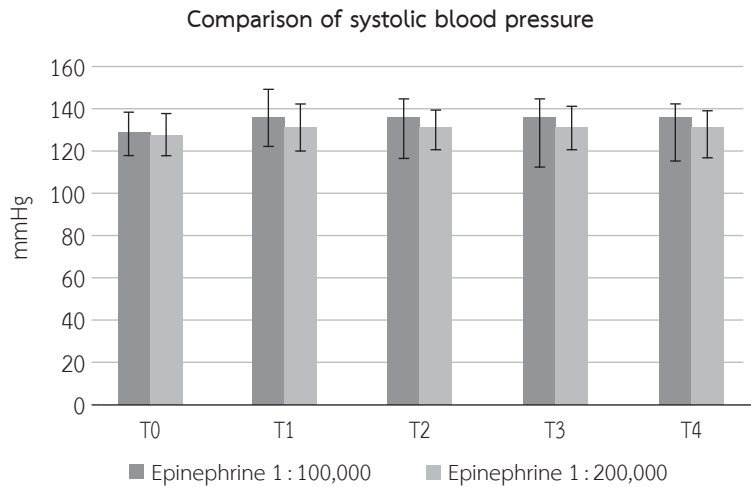
*p*-value of independent t-test except systolic blood pressure at T0 and diastolic blood pressure at T1 evaluated with Mann-Whitney U test. (*p* < 0.05)

PR between 2 groups of epinephrine (1 : 100,000 and 1 : 200,000) using the independent sample t-test except SBP at T0 and DBP at T1 which using Mann-Whitney U test because these groups of data were non-normal distribution. The means of absolute difference of SBP, DBP and PR within each group were compared and evaluated using the Friedman test. Statistical significance

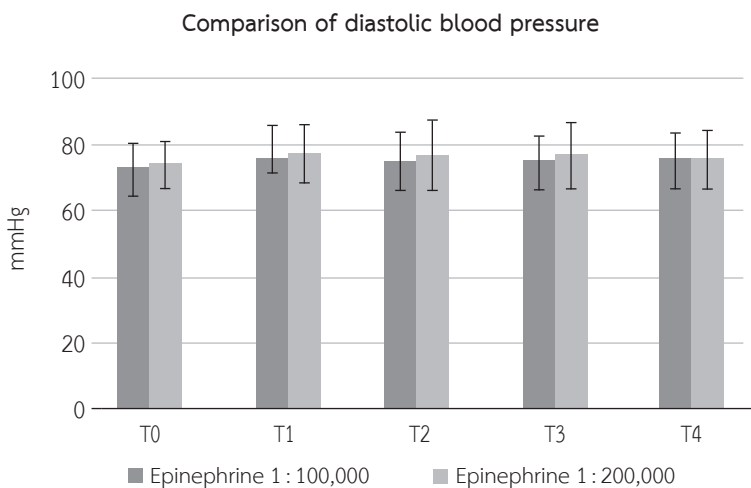
was considered at *p*-value < 0.05.

## Results

The collected data of all 60 patients were divided into 2 groups. The group one (4% articaine with 1 : 100,000 epinephrine) was composed of 13 male and 17 female subjects with average age 67.7 years



รูปที่ 1 เปรียบเทียบค่าความดันเลือดซิสโตลิกของยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 และ 1 : 200,000  
 Fig. 1 Comparison of systolic blood pressure of 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine.



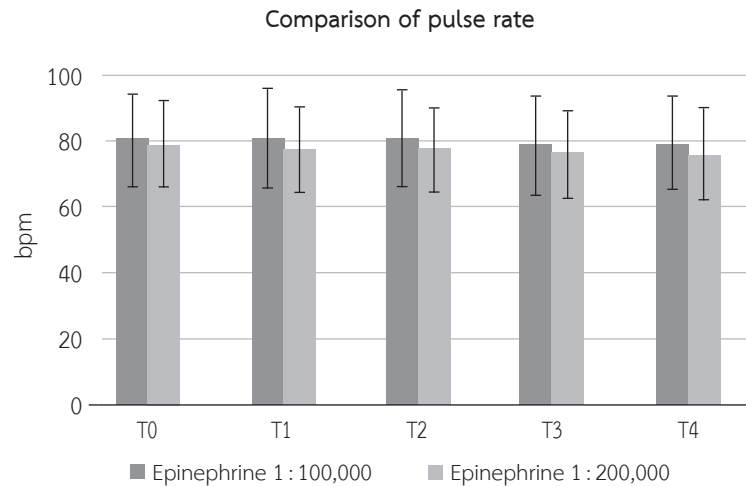
รูปที่ 2 เปรียบเทียบค่าความดันเลือดไดแอสโตลิกของยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 และ 1 : 200,000  
 Fig. 2 Comparison of diastolic blood pressure of 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine.

old. The group two (4% articaine with 1 : 200,000 epinephrine) was composed of 15 male and 15 female subjects with average age 61.1 years old. (Table 1)

The analysis of the NRS and modified dental anxiety score found there were no statistically significant differences between both groups. (Table 2)

According to our study, the group one SBP at T0, T1, T2, T3 and T4 were 128.3 ± 10.2, 135.8 ± 13.4, 130.8 ± 14.3, 128.8 ± 16.3 and 129.1 ± 13.8 mmHg respectively. The group one DBP were 72.5 ± 8.03, 75.9 ± 9.19, 74.4 ± 9.55, 74.2 ± 8.70 and 74.9 ± 8.62 mmHg respec-

tively. The group one PR were 80.0 ± 13.9, 80.4 ± 15.3, 80.2 ± 15.3, 78.8 ± 14.8 and 78.3 ± 15.3 bpm respectively. Meanwhile, the group two SBP at T0, T1, T2, T3 and T4 were 127.7 ± 10.1, 131.8 ± 11.0, 130.6 ± 9.70, 130.6 ± 10.9 and 128.3 ± 11.3 mmHg respectively. The group two DBP were 73.8 ± 7.16, 77.2 ± 8.86, 76.9 ± 10.4, 76.3 ± 10.4 and 75.43 ± 8.92 mmHg respectively. The group two PR were 78.8 ± 13.2, 76.8 ± 12.9, 77.2 ± 13.1, 76.1 ± 13.4 and 75.7 ± 13.6 bpm respectively. The alterations of the SBP, DBP, and PR after the injection between two groups had no statistically significant difference. (Table



รูปที่ 3 เปรียบเทียบค่าชีพจรของยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 กับ 1 : 200,000

Fig. 3 Comparison of pulse rate of 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine.

ตารางที่ 4 เปรียบเทียบค่าเฉลี่ยของความดันเลือดซิสโตลิก ความดันเลือดไดแอสโตลิก และค่าชีพจรของยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 และ 1 : 200,000 ในช่วงเวลาที่ต่างกัน

Table 4 Comparison the means of absolute difference of systolic blood pressure, diastolic blood pressure and pulse rate of 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine at different periods.

Hemodynamic parameters (units of measurement)	Group	The means of absolute difference				p-value
		T0-T1	T0-T2	T0-T3	T0-T4	
Systolic blood pressure (mmHg)	1	10.2 ± 10.2	11.0 ± 7.14	12.9 ± 8.79	12.5 ± 8.25	0.32
	2	10.0 ± 8.76	9.33 ± 7.51	9.80 ± 8.44	10.6 ± 6.16	0.51
Diastolic blood pressure (mmHg)	1	6.23 ± 6.06	6.83 ± 4.54	5.80 ± 4.44	6.93 ± 5.01	0.91
	2	5.53 ± 4.90	6.23 ± 5.12	6.30 ± 4.79	5.80 ± 3.76	0.29
Pulse rate (bpm)	1	5.60 ± 4.99	5.73 ± 4.50	5.20 ± 4.35	6.37 ± 4.99	0.80
	2	6.87 ± 6.16	7.30 ± 7.51	7.50 ± 7.50	8.43 ± 7.63	0.11

p-value of the means of absolute difference of systolic blood pressure, diastolic blood pressure, and pulse rate within each group evaluated with Friedman test. (p < 0.05)

3 and Fig. 1-3)

All the parameters in both groups increased to the peak level immediately after injection (T1) except only the PR of group two reached the peak level at 5 minutes after injection (T2) and then all of them had gradually decreased approximately back to the baseline within 15 minutes after injection (T4).

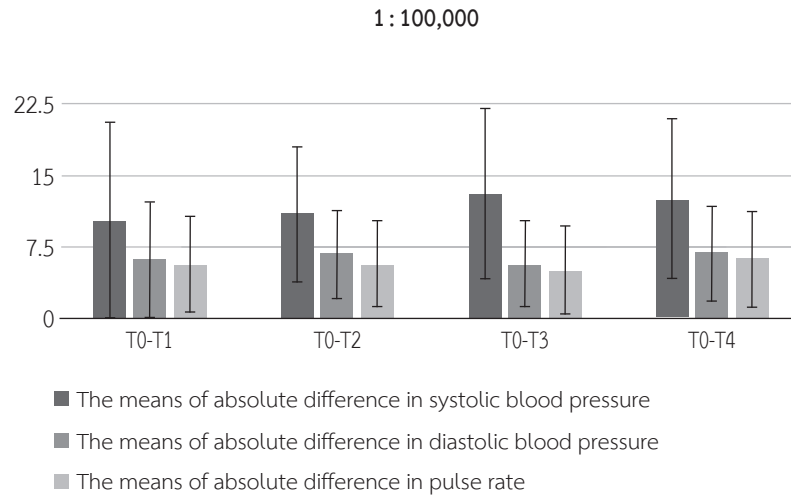
The means of absolute difference of SBP, DBP and PR after injected 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine at T1, T2, T3, and T4 compared

to T0 (baseline) found there were no statistically significant differences of changes. The absolute differences were calculated using the formula for absolute difference calculation. The results were analyzed for the mean and SD afterwards. (Table 4 and Fig. 4, 5)

Formula for absolute difference calculation :  $|x_0 - x_i|$

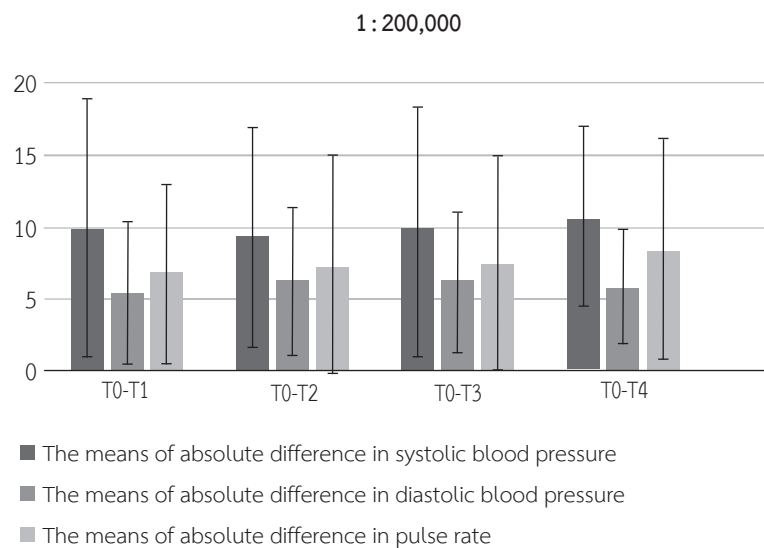
Where  $x_0$  = SBP, DBP, and PR at 5 minutes before the injection (T0 : baseline)

$x_i$  = SBP, DBP, and PR at immediately, 5, 10, and 15 minutes after the injection, respectively



รูปที่ 4 ค่าเฉลี่ยสมบูรณ์ของความดันเลือดซิสโตลิก ความดันเลือดไดแอสโตลิก และค่าชีพจรของยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 100,000 ในช่วงเวลาที่ต่างกัน

Fig. 4 The means of absolute difference of systolic blood pressure, diastolic blood pressure and pulse rate of 4% articaine with 1 : 100,000 epinephrine at different periods.



รูปที่ 5 ค่าเฉลี่ยสมบูรณ์ของความดันเลือดซิสโตลิก ความดันเลือดไดแอสโตลิก และค่าชีพจรของยาชาอาร์ติเคน 4% ที่มีความเข้มข้นของเอพิเนฟริน 1 : 200,000 ในช่วงเวลาที่ต่างกัน

Fig. 5 The means of absolute difference of systolic blood pressure, diastolic blood pressure and pulse rate of 4% articaine with 1 : 200,000 epinephrine at different periods.

### Discussion

There were no statistically significant difference in hemodynamic parameters (SBP, DBP, and PR) in the same collecting time between two groups. The alteration of blood pressure and pulse rate compared to baseline (T0) found that the means of absolute dif-

ference of SBP, DBP, and PR in each group showed no statistically significant difference. Similarly, Moaddabi et al found that there was no significant difference in increasing the blood pressure after maxillary infiltration by using 4% articaine with epinephrine 1 : 100,000 and 2% lidocaine with epinephrine 1 : 80,000. However, the

vasoconstriction or the painful stimulus could be the cause of increasing blood pressure in the patient.<sup>(3)</sup>

Corresponding to the study of Ogunlewe et al which found no statistically significant difference between the SBP, DBP and PR in the two groups, 2% lignocaine with 1 : 80,000 adrenaline and 2% lignocaine without vasoconstrictor, measured before surgery, during the surgery 3-6 minutes after local anesthetic injection, during tooth extraction, and 15 minutes after tooth extraction.<sup>(13)</sup> Likewise, Silvestre et al reported no significant hemodynamic changes at three different timepoints during routine dental procedure in well-controlled hypertensive patients who received anesthetic use 4% articaine with 1 : 200,000 epinephrine or 3% mepivacaine without vasoconstrictor.<sup>(14)</sup> Elad et al reported articaine 4% with 1 : 200,000 epinephrine was comparably as safe as lidocaine 2% with 1 : 100,000 epinephrine in cardiovascular patients.<sup>(15)</sup>

On the other hand, Brand and Abraham-Inpijn said using the local anesthetic with 1 : 100,000 epinephrine resulted in the mean value of heart rate and blood pressure being higher than the injection of the same anesthetic without epinephrine.<sup>(16)</sup> Hersh et al reported the mean SBP and heart rate were significantly elevated ( $p < 0.05$ ) with use 4% articaine with 1 : 100,000 epinephrine versus use 4% articaine with 1 : 200,000 epinephrine.<sup>(17)</sup> Abu-Mostafa et al studied in 3 groups, group one: 2% lidocaine with 1 : 80,000 epinephrine, group two: 4% articaine with 1 : 100,000 epinephrine and group three: 4% articaine with 1 : 200,000 epinephrine and found no difference of DBP, heart rate, and oxygen saturation after anesthesia among the three groups. However, articaine 4% with 1 : 200,000 epinephrine had significant lesser effect on SBP than lidocaine 2% with 1 : 80,000 epinephrine and the least effect on other parameters. Therefore, 4% articaine with 1 : 200,000 epinephrine was considered safer than 2% lidocaine

with 1 : 80,000 epinephrine and 4% articaine with 1 : 100,000 epinephrine and was recommended for local anesthesia before tooth extraction in normal patient.<sup>(18)</sup>

When comparing the mean SBP, DBP and PR at different points of time to the period of 5 minutes before injection (T0 : baseline) found that almost all hemodynamic parameters changed to the peak level immediately after injection (T1) except the mean pulse rate of group two reached the peak level at 5 minutes after injection (T2) and then all of them had gradually decreased approximately back to the baseline within 15 minutes (T4). Our results related to the study of Brown and Rhodes which concluded that the half-life of epinephrine was usually very short (approximately less than 1 minute) and it was eliminated from blood stream in approximately less than 10 minutes. From this study supported that BP and PR mostly increased immediately and returned to the baseline within 15 minutes.<sup>(7)</sup> Another study from Heradstveit et al indicated that the peak concentration of epinephrine was 1 minute and the half-life was about 2.6 minutes.<sup>(19)</sup>

Many studies showed that epinephrine has a rapid onset and relatively short duration depending on the route of admission and the individual's factors, It supported our finding that blood pressure and pulse rate mostly rose immediately after injection and gradually returned to baseline within 15 minutes.<sup>(20)</sup>

The blood pressure was increasing to the peak level immediately after the injection (T1) because epinephrine binds to the beta-1 receptor found in the postsynaptic region of cardiac muscle neurons. The result of this binding increases heart rate and cardiac muscle contraction, increasing the volume of cardiac output, then leading to blood pressure increases. According to a previous study, targeted activation of the beta-1 receptor in the cardiac muscle stimulates sinoatrial (SA) nodal, atrioventricular (AV) nodal, and

ventricular muscular firing, thus increasing heart rate and contractility. These two increased values, and the stroke volume, and cardiac output also increased. As either stroke volume or heart rate increased, both of which increased with targeted activation of the beta-1 receptor, cardiac output increased, thus increasing perfusion to tissues throughout the body.<sup>(21)</sup>

Another possible reason was injection pain which stimulated the increasing of hemodynamic parameters immediately.<sup>(22,23)</sup> Injection is one of noxious stimuli which can stimulate nociceptors. According to Brand et al reported that the nociceptive signals could stimulate the sympathetic nervous system and adrenomedullary secretion of the catecholamines. The adrenomedullary cells can also produce a peptide transmitter, substance P, that may lead to tachycardia and an increase in blood pressure. This study concluded that pain plays an important role in the individual cardiovascular response during dental injection. Moreover, Brand and Abraham-Inpijn also mentioned that signifi-

cantly increasing of both systolic and diastolic blood pressure could be induced by other painful dental treatments, like ultrasonic subgingival debridement without local anesthetics.<sup>(16)</sup>

From our study, all hemodynamic parameters reached to the peak level within 5 minutes and gradually decreased back to the baseline within 15 minutes. Hence, the use of 4% articaine with epinephrine 1 : 100,000 and 1 : 200,000 in hypertensive patients should focus on monitoring vital signs of the patients carefully after injection.

The data in this study were limited to the subject numbers of the well-controlled hypertensive participants, therefore, future studies are suggested to study in larger populations.

## Conclusion

Both 4% articaine with 1 : 100,000 and 1 : 200,000 epinephrine had no statistically significant difference in hemodynamic changes.

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