

ตำแหน่งของรูขากรรไกรล่างที่สัมพันธ์กับอายุที่เปลี่ยนไป: การศึกษาโดยใช้ภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ลำรังสีรูปกรวย Age-related changes of mandibular foramen position: a cone-beam computed tomography study

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บทคัดย่อ

วัตถุประสงค์ของการวิจัยนี้เพื่อวิเคราะห์ความสัมพันธ์ระหว่างอายุที่เปลี่ยนแปลงไปกับตำแหน่งรูขากรรไกรล่าง โดยใช้ภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ลำรังสีรูปกรวยของคนไทยในกลุ่มอายุที่แตกต่างกัน ภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์ลำรังสีรูปกรวยจำนวน 66 ภาพ ถูกแบ่งออกเป็น 3 กลุ่มอายุระยะต่าง ๆ และวัดโดยผู้ทดสอบที่ได้ทำการทดสอบความเชื่อถือได้ หลังจากจัดบันทึกข้อมูลในตำแหน่งแนวตั้งและแนวนอนจากรูขากรรไกรล่างเรียบร้อยแล้ว ข้อมูลจะถูกนำมาวิเคราะห์โดยใช้การวิเคราะห์ความแปรปรวนทางเดียว ผลการศึกษาพบว่า ในตำแหน่งแนวนอนรูขากรรไกรล่างอยู่ในตำแหน่งค่อนข้างด้านหน้าเล็กน้อยในกลุ่มอายุที่มากขึ้น ส่วนในตำแหน่งแนวตั้งพบว่า รูขากรรไกรล่างอยู่ในตำแหน่งเหนือสันเว้าโคโรนอยด์ในกลุ่มผู้สูงอายุชาวไทย สรุปได้ว่าตำแหน่งรูขากรรไกรล่างเปลี่ยนแปลงตามกลุ่มอายุที่เพิ่มมากขึ้นในกลุ่มผู้สูงอายุ ตำแหน่งรูขากรรไกรล่างอยู่ในตำแหน่งค่อนข้างด้านหน้าและสูงขึ้น จากงานวิจัยนี้จึงแนะนำให้ทันตแพทย์จัดฟันในตำแหน่งสูงขึ้นเหนือสันเว้าโคโรนอยด์

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Received 24 August 2021; revised 25 October 2021; accepted 31 October 2021

คำสำคัญ: สันเว้าโคโรนอยด์ รูขากรรไกรล่าง

Abstract The objective of the study was to analyze the relationship between age changing and the position of mandibular foramen using cone-beam computed tomogram (CBCT) in different age groups of Thai patients. Sixty-six CBCT samples were divided into 3 different age groups. Distances were measured by a reliable examiner. Then horizontal and vertical positions of mandibular foramen were determined by calculation. One-way ANOVA test were used to analyze data. In the horizontal dimension, the mandibular foramen slightly moved anterior with advancing age, conversely, in the vertical dimension, the mandibular foramen located above coronoid notch in elderly Thai patient. The location of mandibular foramen changed according to age. In elderly subject, mandibular foramen tended to move anteriorly and upward. This study suggested that injecting needle should be placed slightly above coronoid notch.

Keywords: coronoid notch, mandibular foramen

Introduction

The mandibular foramen is one of anatomical landmark that is important for local anesthetic technique, it is also a safe surgical landmark during ramus osteotomy.⁽¹⁾ Because it has vital structure, the inferior alveolar neurovascular bundle, that runs through foramen and supplies chin, lower lip, vestibular gingivae, alveolus and mandibular teeth.⁽²⁾ Therefore, a comprehensive understanding of structural landmarks on the mandible is essential to guide the accurate position which leads to a successful mandibular nerve block, as well as the safety outcome of ramus osteotomy.

The mandibular foramen is located on the inner aspect of the ramus, approximately at the midpoint of the sagittal, vertical dimensions of the ramus and behind the lingula.⁽³⁾ Because the mandibular foramen cannot be verified clinically, its correct location has been determined using specific mandibular landmarks^(4,5) and different study methods, including dried human mandible⁽⁴⁾ and radiographs, such as panoramic, cephalometric, computerized tomography (CT) as well as analysis of cone-beam computed tomography

(CBCT). According to Kositbowornchai et al in 2007⁽⁶⁾ the accuracy of panoramic radiographic measurement was compared with dry mandible measurement for localizing the position of lingula, and a high concordance between the measured distances in panoramic radiographs and dry mandibles was found. Al-Shayyab et al in 2018⁽⁷⁾ used CBCT to analyze the position of mandibular foramen. Nowadays many studies reported about measuring distances of mandibular foramen in growth group and adult group, such as the study of Kang et al in 2013⁽⁸⁾ which reported about locating of mandibular foramen using CT images. The subject was separated into 2 groups, 49 patients, aged 8-16 years old (growth group), and 59 patients, aged 18-25 years old (adult group). The result showed that the distance from the mandibular foramen to the anterior ramus increased with age. Epars et al in 2015⁽⁹⁾ measured perpendicular height (height of mandibular foramen) from the occlusal plane to mandibular foramen using CT measurements. The subjects were divided into 2 subject groups which were 49 patients (growth group) (8-16 years old) and 59 patients (adult group) (18-25

years old). Therefore, this study was performed about the relationship between age changing and the position of mandibular foramen using CBCT in adult, middle age, and elderly patients.

Therefore, the aim of this study was to analyze the relationship between aging and the position of mandibular foramen using CBCT in adult, middle age, and elderly Thai patients to identify reliable target area for the inferior alveolar nerve block and safety zone for surgical procedures, such as the sagittal split ramus osteotomy (SSRO).

Materials and methods

CBCT scanning image was performed using i-CAT tomography scanner (Imaging Sciences International Inc., USA) with the following settings: 120 kV and 3-8 mA current. All CBCT images were captured with the use of 17-19 i-CAT, 0.25 mm voxel size resolution and 23.2 × 17.0 cm field of view.

The inclusion criteria of the subjects were 1) patients with CBCT images taken between 2008-2019 and must be at least 20 years old and 2) patients must had at least 2 teeth; molar and premolar of the same side on both maxilla and mandibular arches. Exclusion criteria were 1) unclear images, 2) patients with edentulous jaw and 3) patients with pathologic lesion or congenital anomaly.

G*Power version 3.1.5 was used to calculate the sample size of the research. The one-way ANOVA was selected for the statistical test. Effect size conventions, the researcher used 0.40 to represent the large value. Error of problem was 0.05, power of test was 0.08, and the number of groups were 3 groups. The total sample size calculated from G*Power program was 66.

The 66 sample sizes (31 males and 35 females) were used for the measurement distance of landmark and reference planes of mandibular foramen from

ตารางที่ 1 ขนาดกลุ่มตัวอย่างในแต่ละช่วงอายุ

Table 1 The sample size in each age group.

Age	Group	Sample size
20-39 years old	A	22
40-59 years old	B	22
More than 60 years old	C	22

CBCT image. CBCT data were gathered from patient aged 20 to more than 60 years old and were divided in 3 groups, 22 samples for each group. The 3 groups were divided according to age difference: group A (20-39 years), group B (40-59 years) and group C (more than 60) as in Table 1.

Data collection

CS 3D imaging program was used for measurement of the distances from mandibular foramen to landmarks. The calibrated examiner was blinded to any other patients' details. Firstly, the CS 3D imaging program was opened, then the oblique slicing mode was chosen (Fig. 1). In axial plane, examiner slid plane until found first lingula (Fig. 2), then set sagittal plane (light grey line) passing lingula and running across the teeth at that side. The coronal plane was slid (dark grey line) until it intersected at lingula (Fig. 3). The mandibular foramen (white point) was marked from coronal view (Fig. 4) then examiner measured the distances from mandibular foramen to landmarks and reference planes of mandible from CBCT image (Fig. 5 and 6). Description of the points, planes and lines was summarized in Table 2.

Data analysis

All statistical analyses were performed using the Statistical Package for the Social Science for Mac (version 25.0, SPSS, Chicago, IL, USA). Statistical significance was set at $p < 0.05$.



รูปที่ 1 โปรแกรมสร้างภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์สร้างรูปกรวยในแบบหันเฉียง

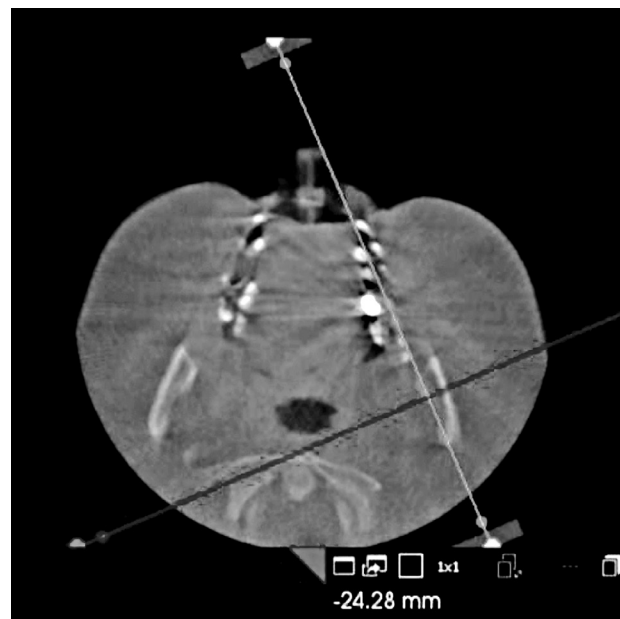
Fig. 1 CS 3D imaging program in oblique slicing mode.



รูปที่ 2 เลื่อนระนาบตามแกนจนพบลิ้งกูลาตำแหน่งแรก

Fig. 2 Sliding in axial plane until found first lingula.

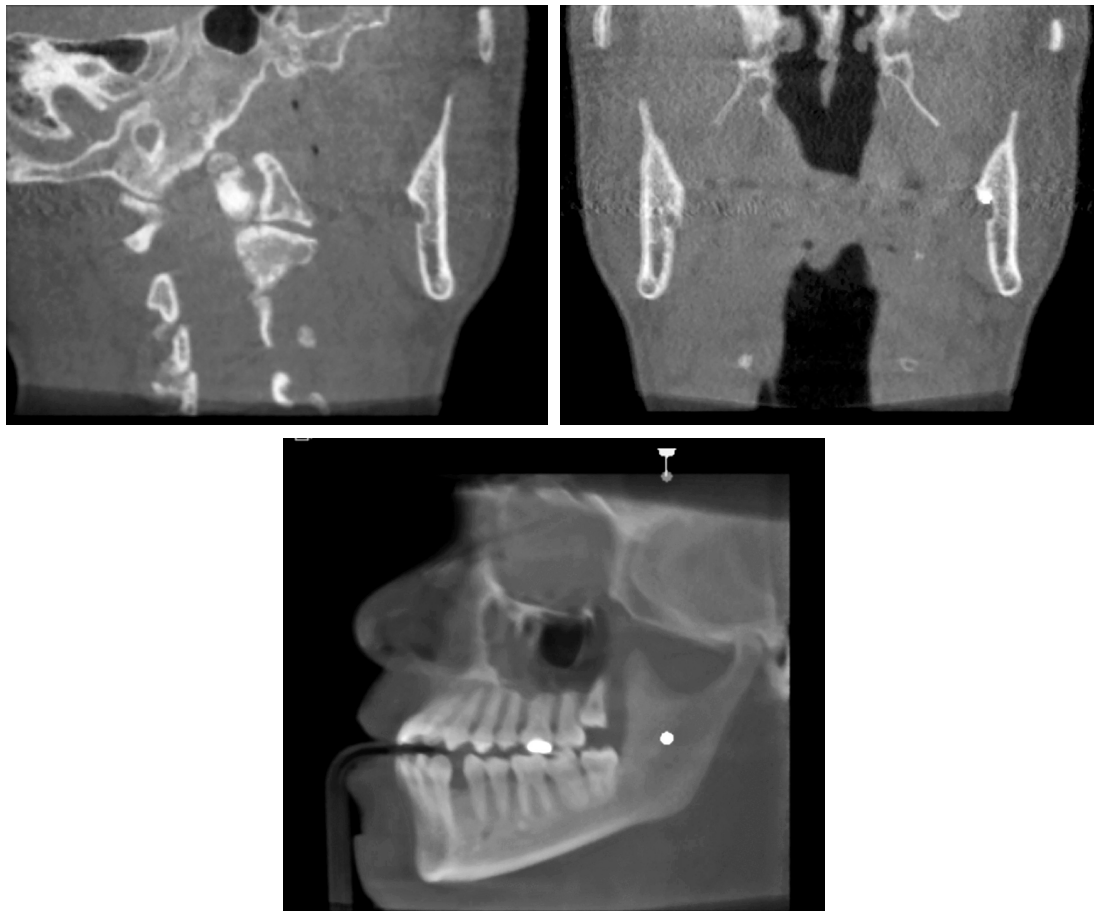
For the intraclass correlation analysis, the CBCT images were evaluated by experienced oral and maxillofacial surgeon. The inter-rater reliability was performed using intraclass correlation coefficient (ICC) to determine the degree of concordance between the examiner and the experienced oral and maxillofacial



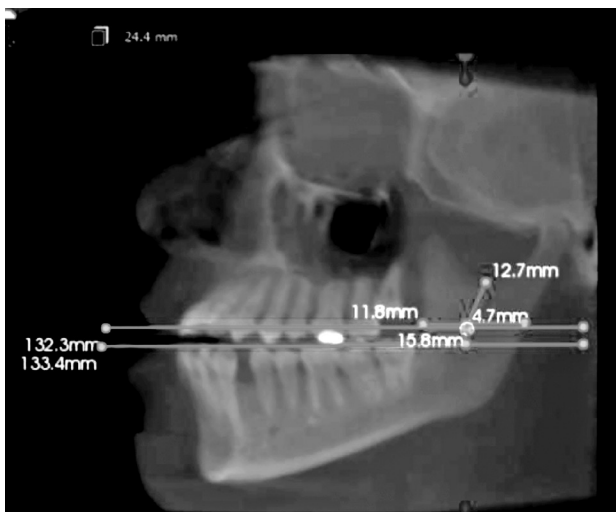
รูปที่ 3 กำหนดให้ระนาบแบ่งซ้ายขวา (เส้นสีเทาอ่อน) ลากผ่านลิ้งกูลา โดยตัดผ่านฟันที่ด้านนั้น และเลื่อนระนาบแบ่งหน้าหลัง (เส้นสีเทาเข้ม) ไปตัดที่ลิ้งกูลา

Fig. 3 Setting of sagittal plane (light grey line) passing lingula and running across the teeth at that side. Sliding in coronal plane (dark grey line) until it intersected at lingula.

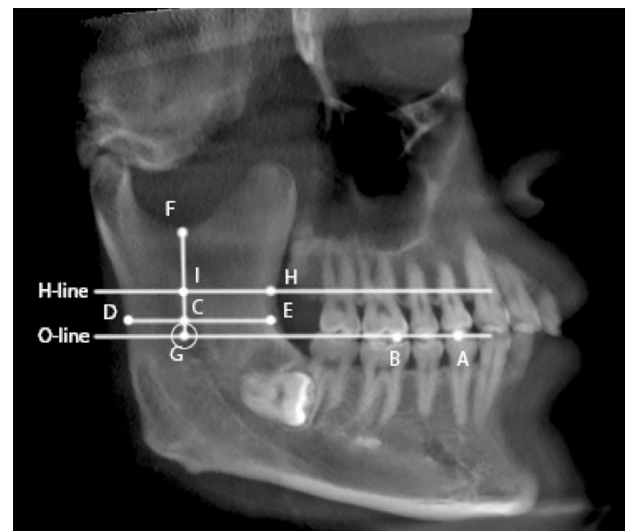
surgeon, prior to examining the experimental CBCT images by the same examiner. The ICC was ranged



รูปที่ 4 ทำเครื่องหมายรูเปิดขากรรไกรล่าง (จุดสีขาว) จากมุมมองระนาบแบ่งหน้าหลัง
 Fig. 4 Marking of mandibular foramen (white point) from coronal view.



รูปที่ 5 วัดระยะทางจากรูเปิดขากรรไกรล่างถึงจุดบ่งชี้และระนาบอ้างอิงของขากรรไกรล่างจากภาพรังสีส่วนตัดอาศัยคอมพิวเตอร์สร้างรูปกรวย
 Fig. 5 Measurement of the distances from mandibular foramen to landmarks and reference planes of mandible from CBCT image.



รูปที่ 6 จุด ระนาบ และเส้นสำหรับวัดตำแหน่ง รูเปิดขากรรไกรล่าง
 Fig. 6 The points, planes, and lines for the measurement of mandibular foramen position.

ตารางที่ 2 คำอธิบายของจุด เส้นระนาบ และเส้นสำหรับการวัดตำแหน่งรูเปิดขากรรไกรล่าง

Table 2 Description of the points, planes and lines for the measurement of mandibular foramen position.

	Description
Point	A Buccal cusp tip of mandibular premolar
	B Mesiobuccal cusp tip of the mandibular molar
	C Superior border of mandibular foramen
	D The most posterior point of the ramus on the imaginary line which was parallel to the occlusal plane and passed through point C
	E The most anterior point of the ramus on the imaginary line which was parallel to the occlusal plane and passed through point C
	F The deepest concavity of sigmoid notch
	G Point on occlusal plane which started from point C to O line at a right angle
	H Coronoid notch
	I Point on H line which started from point C to H line at a right angle
Line	O line Line from point A to point B which represented occlusal plane
	H line Line that was parallel to the occlusal plane and crossed point H
	CE Line between the point C and point E that was parallel to O line
	CD Line between the point C and point D that was parallel to O line
	CF Line between point C and point F
	CG Line between point C and point G
	CI Line between point C and point I

from 90.0% to 100%, the range of the 95% confidence interval (CI) was 0.839-0.999 for all various measurements. This indicated an excellent significant agreement ($p < 0.001$) between the examiner and the experienced oral and maxillofacial surgeon.

The Komogorov-Smironov test was performed to evaluate whether the data followed a normal distribution. Descriptive statistics for the included subjects and their measurements were generated. First, measurements were compared among the 3 age groups in the entire cohort and within the same gender. Paired-sample t-test was used to analyze differences in measurements between the right and left sides of the mandible. One-way ANOVA test was used to analyze differences in measurements between groups. When one-way ANOVA test was used, the statistical significance for each pair of means was determined

using post hoc multiple comparisons.

Results

Intra-examiner reliability

The intraclass correlation coefficient was used to determine the degree of concordance between the examiner and the experienced oral and maxillofacial surgeon, prior to examining the experimental CBCT-images by the same examiner. Excellent correlation was achieved with values ranging from 98.3% to 99.0%, and the range of the 95% CI was 0.957-0.996 for all various measurements (Table 3).

General information

Due to the limitations in meeting the inclusion criteria, a purposive sampling of 60 CBCT images could

ตารางที่ 3 ตรวจสอบความน่าเชื่อถือภายในตัวบุคคล

Table 3 Intra-examiner reliability.

Parameter	Intraclass correlation coefficient (ICC)	95% confidence interval		p-value*
		Lower bound	Upper bound	
CE	0.987	0.968	0.968	<0.001
CD	0.984	0.995	0.995	<0.001
CF	0.983	0.960	0.960	<0.001
CG	0.983	0.994	0.994	<0.001
CI	0.990	0.957	0.957	<0.001

CD = line between superior border of mandibular foramen and the most posterior point of the ramus, CE = line between superior border of mandibular foramen and the most anterior point of the ramus, CF = line between superior border of mandibular foramen and the deepest concavity of sigmoid notch, CG = line between superior border of mandibular foramen and point on occlusal plane, CI = line between superior border of mandibular foramen and point on H line (line that was parallel to the occlusal plane and crossed coronoid notch), p-value* = p-value of intraclass correlation coefficient (ICC)

only be included. The excluded CBCT data were due to unclear images, patients that had edentulous jaws and patients that had pathologic lesions or congenital anomalies. There was a total of 31 male (47.0%), and 35 female (53.0%)

The subjects were divided according to gender and age groups. They were stratified into 3 age groups: 20-39 years old (group A), 40-59 years old (group B), and more than 60 years old (group C). For the detail of each group, group A included 59.1% male and 40.9 % female subjects with 26.0 year-old average age, group B included 45.5% male and 54.6% female subjects with 50.4 year-old average age, and group C included 36.4% male and 63.6% female subjects with 65.4 year-old average age (Table 4).

Comparison between left and right sides of the mandibular foramen

From Table 5 showed that comparatives between sides (left and right) of both male and female were not significantly different in CE, CD, CF, CG and CI ($p > 0.05$). When consider to male and female founded, both male and female also did not have any significant

ตารางที่ 4 สถิติเชิงพรรณนาของกลุ่มที่ต้องการศึกษา(เพศและอายุ)(จำนวนกลุ่มตัวอย่าง = 66)

Table 4 Descriptive statistics of the study groups (gender and ages) (N = 66).

Age group	N	Male (%)	Female (%)	Age years (mean ± SD)
A	22	13 (59.1)	9 (40.9)	26.0 ± 4.76
B	22	10 (45.5)	12 (54.5)	50.4 ± 5.86
C	22	8 (36.4)	14 (63.6)	65.4 ± 3.76
Total	66	31 (47.0)	35 (53.0)	43.3 ± 17.3

A = 20-39 years old, B = 40-59 years old, C = more than 60 years old, SD = standard deviation

difference in CE, CD, CF, CG and CI ($p > 0.05$). Therefore, the result above could summarize that side (left and right) did not affect CE, CD, CF, CG and CI.

Comparison of the average distances among age groups

One-way ANOVA test indicated that comparing between age group of both male and female showed significant difference in CE, CF, and CI ($p < 0.05$). Group C exhibited the lowest average values of CE, CF, and CI, especially CI which the value decreased comparing

ตารางที่ 5 การเปรียบเทียบระหว่างด้านซ้ายและด้านขวาของรูเปิดขากรรไกรล่าง จากขากรรไกรล่างของเพศชายและเพศหญิง (จำนวนกลุ่มตัวอย่าง = 66)

Table 5 Comparison between left and right sides of the mandibular foramen of the mandible in males and females (N = 66).

Variable	Side	Gender					
		Male n (mean ± SD)	<i>p</i>	Female n (mean ± SD)	<i>p</i>	Total n (mean ± SD)	<i>p</i>
CE	Left	17 (15.5 ± 2.72)	0.628	16 (14.4 ± 2.44)	0.742	33 (15.1 ± 2.67)	0.620
	Right	14 (15.2 ± 2.38)		19 (14.2 ± 2.73)			
CD	Left	17 (15.9 ± 1.94)	0.506	16 (15.3 ± 1.58)	0.194	33 (15.7 ± 1.84)	0.203
	Right	14 (16.1 ± 1.98)		19 (15.9 ± 1.65)			
CF	Left	17 (16.0 ± 3.53)	0.796	16 (14.0 ± 2.67)	0.163	33 (15.3 ± 3.40)	0.336
	Right	14 (16.2 ± 3.73)		19 (15.0 ± 2.83)			
CG	Left	17 (7.16 ± 3.04)	0.966	16 (6.40 ± 3.81)	0.549	33 (6.91 ± 3.32)	0.795
	Right	14 (7.18 ± 2.69)		19 (5.86 ± 2.43)			
CI	Left	17 (2.24 ± 2.79)	0.952	16 (1.23 ± 3.67)	0.229	33 (1.90 ± 3.12)	0.524
	Right	14 (2.27 ± 2.78)		19 (0.03 ± 3.67)			

CD = line between superior border of mandibular foramen and the most posterior point of the ramus, CE = line between superior border of mandibular foramen and the most anterior point of the ramus, CF = line between superior border of mandibular foramen and the deepest concavity of sigmoid notch, CG = line between superior border of mandibular foramen and point on occlusal plane, CI = line between superior border of mandibular foramen and point on H line (line that was parallel to the occlusal plane and cross coronoid notch), *p* = *p*-value of independent sample t-test (significance of right to left), SD = standard deviation, total = both male and female

with groups A and B (Table 6).

Post hoc multiple comparisons test, a sub-statistics, showed the difference between groups, from overall results found in CE and CF had 1 pair of difference which was group A and group C, for CI had 2 pairs of difference which were groups C-A and groups C-B.

Discussion

The mandibular foramen is one of the essential anatomical landmarks for local anesthetic injection.⁽¹⁾ Moreover, this structure is necessary to be verified for a safe ramus osteotomy procedure because it has vital structure, an inferior alveolar neurovascular bundle, that runs through foramen. Due to the mandibular foramen cannot be verified clinically, its correct location has been determined using specific mandibular landmarks and various methods, including dried human mandible and radiological studies with

2D panoramic and cephalometric radiographs or 3D CT and CBCT. CBCT has been suggested as the radiographic technique of choice which presents advantages over conventional 2D radiographic techniques by examiner and providing details accuracy and reliable 3D information.⁽⁷⁾ Therefore, this study based on CBCT radiographs and adopted similar methods, measurements, ratios, and landmarks proposed in some previous studies.

The results of this study indicated that the mandibular foramen was positional bilateral similarity. Shalini et al also reported that there was no statistically significant difference in the location of mandibular foramen on the right and left sides (*p* > 0.05) in both the anteroposterior axis and superoinferior axis.⁽¹⁰⁾

In the horizontal dimension, we found that the mean distances of the mandibular foramen to the anterior border and posterior border of ramus were 15.0 ± 2.59 mm and 15.8 ± 1.86 mm respectively. Fin-

ตารางที่ 6 การเปรียบเทียบค่าระยะทางเฉลี่ยของรูเปิดขากรรไกรล่างในระหว่างกลุ่มอายุ

Table 6 Comparison of the average distances among age groups (N = 66).

Variable	Age group	Gender	
		Total n (mean ± SD)	p
CE	A	22 (15.1 ± 2.12)	0.013*
	B	22 (15.7 ± 2.88)	
	C	22 (14.2 ± 2.63)	
	Total	66 (15.0 ± 2.59)	
CD	A	22 (16.0 ± 1.97)	0.573
	B	22 (15.6 ± 1.69)	
	C	22 (15.9 ± 1.92)	
	Total	66 (15.8 ± 1.86)	
CF	A	22 (16.5 ± 3.50)	0.025*
	B	22 (15.1 ± 3.25)	
	C	22 (14.9 ± 3.43)	
	Total	66 (15.6 ± 3.45)	
CG	A	22 (7.41 ± 2.89)	0.159
	B	22 (6.36 ± 2.88)	
	C	22 (6.68 ± 3.31)	
	Total	66 (6.85 ± 3.03)	
CI	A	22 (3.41 ± 1.78)	0.012*
	B	22 (2.38 ± 2.37)	
	C	22 (-0.91 ± 3.52)	
	Total	66 (1.77 ± 3.16)	

A = 20-39 years old, B = 40-59 years old, C = more than 60 years old, CD = line between superior border of mandibular foramen and the most posterior point of the ramus, CE = line between superior border of mandibular foramen and the most anterior point of the ramus, CF = line between superior border of mandibular foramen and the deepest concavity of sigmoid notch, CG = line between superior border of mandibular foramen and point on occlusal plane, CI = line between superior border of mandibular foramen and point on H line (line that was parallel to the occlusal plane and cross coronoid notch), p = p-value of ANOVA test (significance among age groups), SD = standard deviation, total = both male and female

dik et al in 2014, found that the mean distances from the mandibular foramen to the anterior border of the mandible were 15.9 mm in the right mandibles and

16.0 mm in the left mandibles; whereas the mean distances from the mandibular foramen to the posterior border of the mandible were 14.3 mm in the right mandibles and 14.3 mm in the left mandibles in the adult group⁽¹¹⁾, which was in close agreement with our study. However, Afsar et al in 1998, stated that the mandibular foramen could be localized in panoramic radiographs. Their study in Caucasians found that the distance from the mandibular foramen to the anterior border of ramus was 20.2 ± 3.00 mm and the distance from the mandibular foramen to the posterior border of ramus was 12.6 ± 3.00 mm.⁽⁴⁾ Kositbowornchai et al in 2007, used the lingula as a reference. They reported that the distance from the lingula to the anterior border of the ramus on panoramic radiographs was 23.2 ± 3.82 mm.⁽⁶⁾ Also, a study by Trost et al in 2010, found that the mandibular foramen located averagely 17.0 mm from the anterior border of ramus.⁽¹²⁾

The difference of distance from the mandibular foramen to the anterior border of the mandible was statistically significant ($p < 0.05$) in 3 age groups. The distance from the mandibular foramen to the anterior border of the mandible was decreased significantly in advancing age which meant the mandibular foramen was slightly moving anterior with advancing age consequently, in accordance with the research results of Al-Shayyab et al in 2018, which have reported that the mandibular foramen was moving forward with advancing age.⁽⁷⁾

In the vertical dimension, the difference of distance between the mandibular foramen to the coronoid notch was statistically significant ($p < 0.05$) in 3 age groups. Group C exhibited negative average values of CI with average distances ranged -0.91 ± 3.52 mm which meant mandibular foramen was above coronoid notch. This agreed with the study of Al-Shayyab et al in 2018 which have reported that the mandibular foramen

continued to move in a superior direction.⁽⁷⁾ Moreover, the study of Hwang et al in 1990 have reported that mandibular foramen subsequently moved upward with age.⁽¹³⁾

However, the distances were significantly variable according to age, the position of the mandibular foramen and other landmarks were not constant and affected by remodeling occurred with advancing age. The ramus remodeled by means of resorption on the anterior part of the ramus and deposition on the posterior region. The resorption and deposition were self-balanced. The elevating muscles which attached to the ramus influenced in determining the ultimate size and proportion of these mandibular elements. In elderly, the deposition and resorption process were imbalanced which led to a smaller ramus size. Therefore, these remodeling changes would move the mandibular foramen in an anterior and superior direction.⁽⁷⁾

The mandibular foramen and lingula are essential reference points in performing the medial horizontal osteotomy of bilateral sagittal split ramus osteotomy (BSSRO). Several reports suggested that the medial horizontal osteotomy should be “just above the mandibular lingula” and should be extended as faraway back as possible from the tips of the mandibular lingula.⁽¹⁴⁾

Initial localization of the mandibular foramen is an important step in start with the procedure of BSSRO. Nicholson in 1985, reported that the mandibular foramen was eminently located at the antero-posterior midpoint of the ramus halfway between the mandibular notch and the lower surface of the mandible and two-thirds of the way down a line joining the coronoid process to the angle of the mandible.⁽⁵⁾ Apinhasmit et al in 2015, showed that the mandibular foramen was usually localized slightly anterior to the posterior third of the mandibular ramus width, and at

the superior third of the mandibular ramus height.⁽¹⁵⁾ In our study, mandibular foramen was located at approximately half of the length of the mandibular ramus and this finding suggested that for a safe intersection osteotomy should be approximately 10.0 mm from the deepest part of the sigmoid notch, as same as those of Findik et al in 2014.⁽¹¹⁾

It is necessary to locate the landmark for inferior alveolar nerve block during dental treatment for efficient anesthesia. The height level of the mandibular foramen is an important reference for inferior alveolar nerve block. Malamed stated that height of injection was 6 to 10 mm above the occlusal plane.⁽¹⁶⁾ This agreed with our study which found an average distance 6.85 ± 3.03 mm (range 3.82-9.88 mm) above the occlusal plane. Inferior alveolar nerve block technique can use coronoid notch as a reference point. According to CI value in our results, it changed and related to age group especially in elderly group (more than 60 years old) exhibited negative average values of CI which meant mandibular foramen was above coronoid notch.

Therefore, age could affect reference for needle injection point. The most effective area for inferior alveolar nerve block in group A (age 20-39 years old) and group B (age 40-59 years old) was to inject at the level of the coronoid notch. On the other hand, in group C (more than 60 years old), injection above the coronoid notch would give the most effective anesthesia.

Conclusion

This study suggested that the location of mandibular foramen changed according to age. In elderly subject, mandibular foramen tended to move anteriorly and upward. However, it was necessary to locate the landmark for inferior alveolar nerve block for

efficient anesthesia. As a result, to know the landmark of anatomical landmark position in different age group may help dentist to perform effective inferior alveolar nerve block in elderly patient. This study suggested injecting needle slightly above coronoid notch for an

inferior alveolar nerve block. Furthermore, knowing the landmark of mandibular foramen position helped surgeon to locate mandibular foramen for a safe surgical landmark for bilateral sagittal split ramus osteotomy in each age group.

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