Dimensions for Midline and Paramidline Mandibulotomy: A Radiographic Study in the Dentate Thai Population

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Background: *Mandibulotomy is an important surgical approach of the oral cavity, oropharynx, and parapharyngeal space.*
Objective: *To provide dimensions for placement of bone cuts for midline (between two central incisors) and paramidline (between lateral incisor and canine) mandibulotomy.*
Material and Method: *Two hundred and sixteen periapical radiographs with the mandibular anterior teeth of 72 healthy Thai dental patients (30 males, 42 females) were selected. The angles between the long axes of the two central incisors (M) and between the lateral incisor and canine (PM) were bilaterally measured using computerized imaging. The horizontal distances (at crestal, middle, and apical levels) between the roots and the alveolar bone heights of the aforementioned teeth were also measured.*
Results: *The angles between the PM (0.00-9.26°) were less convergent than those between the M (0.00-11.66°) ($p < 0.05$). The distances between the PM were 0.60 - 8.03 mm, whereas those between the M were 0.47-6.63 mm ($p < 0.05$). Mean alveolar bone height is 15.88 $\pm$ 1.72 mm in the canine.*
Conclusion: *The paramidline mandibulotomy is done in a wider space than the midline cut and could have a better chance to avoid the extraction of a central incisor and preserve the origin of the genioglossus, geniohyoid, and digastric muscles.*

Keywords: *Midline mandibulotomy, Paramidline mandibulotomy, Periapical radiograph, Dimension*

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Mandibulotomy and a lateral swing of the divided mandible can facilitate surgical access to tumors in the posterior aspect of the oral cavity[1], oropharynx[2], parapharyngeal space[3], nasopharynx[4], the deep lobe of the parotid gland[5] and skull base[6]. The original concept of the mandible bisection at a vertical midline was first developed by Roux in 1836[7]. Since then, several modifications associated with osteotomy sites have been suggested.

Mandibulotomy can be performed via anterior to the mental foramen (medial mandibulotomy) or posterior to the mental foramen (lateral mandibulotomy). Medial mandibulotomy can be further classified into midline mandibulotomy between the two central incisors and paramidline mandibulotomy between the lateral incisor and canine[1,8]. Lateral mandibulotomy is now seldom performed due to its high complication, especially in patients who have undergone radiation therapy[1,2].

Although medial mandibulotomy is a well recognized surgical procedure, data on the anatomical basis for midline and paramidline mandibulotomy are very limited[9,10]. Panoramic radiographs used in these studies are known to have a lower image quality and higher enlargement than those using periapical radiographs[11,12]. Therefore, the present study was performed to compare an anatomical basis for midline and paramidline mandibulotomy by using 216 periapical radiographs of Thai dental patients. Additionally, the gender difference was investigated.

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Material and Method

Two hundred and forty six periapical radiographs of mandibular anterior teeth from 82 Thais were selected from the radiographic collection of the Department of Radiology, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand. All radiographs were taken from noncarcinomic dental patients using the paralleling technique. The radiographs were scanned as digital images at a resolution of 600 dpi by flat scanner (HP Scan*Jet* 7400c, UK) and analyzed with the computer software (UTHSCSA Image Tool for Windows version 3.0) by a single examiner. The bilateral angles between the long axes of the two central incisors (M) and between the lateral incisor and canine (PM) were measured (Fig. 1). The horizontal distances between the roots were also measured at three levels: crestal, middle, and apical levels (Fig. 2). The root lengths and the corresponding alveolar bone heights of the central incisor, lateral incisor, and canine were also determined (Fig. 2). Exclusion criteria were (1) teeth with periodontitis and (2) missing, spacing, crowding and misalignment of anterior teeth.

The measurements were tabulated and separated with respect to side and gender. The Statistical Package for Social Science (version 11.5) was used for the analyses. The mean, standard deviation (SD) and range of each measurement were assessed. The measurements between side and gender were compared using the paired and unpaired *t* tests, respectively. Differences between groups were considered significant at $p < 0.05$. Age difference between genders was also compared by unpaired *t* test. Of the radiographs, 20% were randomly selected and re-measured after an interval of one month for an intraexaminer test. A paired *t* test was performed for testing the statistical significance of intraexaminer difference.

Results

Of all the angles between the roots of the anterior teeth measured from 246 periapical radiographs of 82 subjects, 223 (90.65%) were convergent toward the root apex, 13 (5.28%) were divergent and 10 (4.07%) were parallel. To achieve accurate results, only data from 216 radiographs of 72 subjects with convergent and parallel angles were selected and compared. There were 30 males and 42 females with a mean age of 28.33 $\pm$ 8.95 years and range from 18-54 years. No significant age difference was found between males (27.30 $\pm$ 9.02 years) and females (29.07 $\pm$ 8.94 years) ($p > 0.05$). There were no statistically significant differences between the values of the two measurements of 20% of all radiographs using paired *t* test ($p > 0.05$).

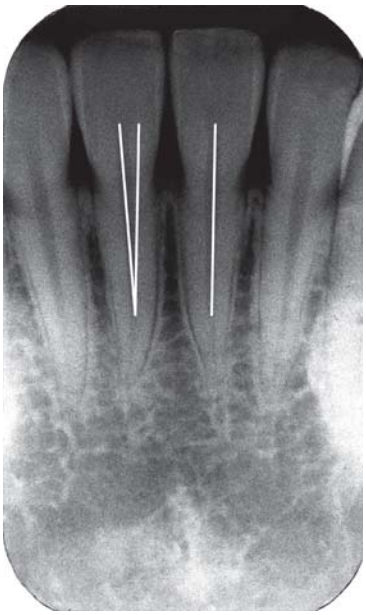

Fig. 1 Angulation between the two mandibular central incisors

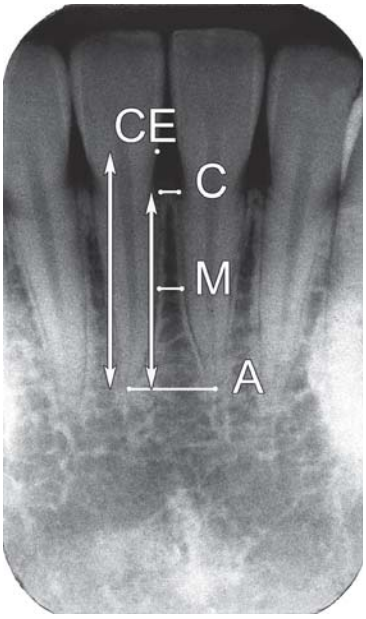

Fig. 2 Showing horizontal distances between the two mandibular central incisors at the crestal (C), middle (M) and apical (A) levels, the left vertical line is the root length of a central incisor measured from the cemento-enamel junction (CE) to apical level (A), whereas the right vertical line is the alveolar bone height of a central incisor measured from the crestal level (C) to the apical level (A)

Table 1 shows that the ranges of the angle between the PM were less convergent (0.00-9.26 degrees) compared with those between the M (0.00-11.66 degrees). There was more significant convergence between the M than those between the right PM and left PM ($p < 0.05$). No significant differences of the M and the right PM and left PM were found between genders ($p > 0.05$).

The horizontal distances between the M and between the PM are demonstrated in Table 2. The distances at crestal, middle, and apical levels between the right PM and the left PM were significantly longer than those between the M ($p < 0.01$). There was no significant difference in the distances between the right PM and the left PM ($p > 0.05$). When comparing genders, no significant difference of the distances between the M and the both PM ($p > 0.05$) was found, except those at the crest level ($p < 0.05$).

Table 3 shows the root length and the alveolar bone height of the central incisor, the lateral incisor, and the canine. There were no significant difference between the right and the left root lengths and the alveolar bone height of the anterior teeth ($p > 0.05$). The differences between the root length and the alveolar bone height of all measurements were less than three millimeters. There was no significant difference regarding the root length and the alveolar bone height between genders ($p > 0.05$), except that of the canine ($p < 0.05$).

Discussion

Resection of tumors at the posterior aspect of the oral cavity, oropharynx, nasopharynx, parapharyn-

Table 1. Angles between the two central incisors (M), and between the lateral incisor and canine (PM)

Subject	N	Right PM (degree)		M (degree)		Left PM (degree)	
		Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Male	30	2.92 ± 2.04	0.00-8.77	4.44 ± 2.73	0.59-11.27	2.45 ± 2.13	0.00-9.26
Female	42	2.83 ± 2.30	0.00-8.42	3.37 ± 3.08	0.00-11.66	3.16 ± 1.86	0.00-7.73
Total	72	2.87 ± 2.18	0.00-8.77	3.82 ± 2.97	0.00-11.66	2.86 ± 1.99	0.00-9.26

Comparison of M and right PM and M and left PM, $p < 0.05$
Comparison of right and left PM, $p > 0.05$
Comparison of either M, right PM or left PM between genders, $p > 0.05$

Table 2. Horizontal distances between the two central incisors (M), and between lateral incisor and canine (PM) of the right and left sides

Level	Subject	N	Right PM (mm)		M (mm)		Left PM (mm)	
			Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Crestal	Male	30	1.40 ± 0.40	0.72-2.38	1.24 ± 0.35	0.60-1.80	1.39 ± 0.35	0.89-2.50
	Female	42	1.66 ± 0.30	1.03-2.18	1.38 ± 0.44	0.47-2.24	1.61 ± 0.44	0.60-2.63
	Total	72	1.56 ± 0.37	0.72-2.38	1.32 ± 0.41	0.47-2.24	1.52 ± 0.42	0.60-2.63
Middle	Male	30	2.27 ± 0.45	1.19-2.99	1.64 ± 0.52	0.56-2.79	2.43 ± 0.60	1.37-3.73
	Female	42	2.51 ± 0.63	0.88-3.89	1.93 ± 0.75	0.60-3.40	2.54 ± 0.71	1.11-4.58
	Total	72	2.41 ± 0.57	0.88-3.89	1.81 ± 0.67	0.56-3.40	2.49 ± 0.66	1.11-4.58
Apical	Male	30	5.65 ± 0.66	4.31-6.84	4.56 ± 0.85	3.30-6.63	5.71 ± 0.87	4.07-8.03
	Female	42	5.46 ± 0.76	4.08-7.00	4.98 ± 0.98	3.01-6.45	5.64 ± 0.95	2.81-7.43
	Total	72	5.54 ± 0.72	4.08-7.00	4.81 ± 0.09	3.01-6.63	5.68 ± 0.91	2.81-8.03

Comparison of M and right PM at three levels, $p < 0.01$
Comparison of M and left PM at three levels, $p < 0.01$
Comparison of right PM and left PM at three levels, $p > 0.05$
Comparison of M between genders, at three levels, $p > 0.05$
Comparison of right and left PM between genders, at the crestal level, $p < 0.05$; at middle and apical levels, $p > 0.05$

Table 3. Root length and alveolar bone height of the central incisor, the lateral incisor and the canine

Measurement (mm)	Subject	N	Central incisor		Lateral incisor		Canine	
			Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Root length	Male	60	13.92 ± 1.54	10.70-16.41	14.30 ± 1.56	10.54-17.44	17.70 ± 1.80	13.85-23.45
	Female	84	13.72 ± 1.12	11.22-15.98	13.99 ± 1.20	10.82-16.15	16.96 ± 1.70	13.37-20.60
	Total	144	13.80 ± 1.31	10.70-16.41	14.12 ± 1.37	10.54-17.44	17.27 ± 1.77	13.37-23.45
Alveolar bone height	Male	60	12.21 ± 1.36	8.59-14.31	12.63 ± 1.40	8.99-15.64	16.29 ± 1.70	12.26-20.66
	Female	84	11.97 ± 1.20	9.33-13.97	12.42 ± 1.19	9.35-15.38	15.58 ± 1.69	11.40-19.33
	Total	144	12.07 ± 1.27	8.59-14.31	12.51 ± 1.29	8.99-15.64	15.88 ± 1.72	11.40-20.66

Comparison of root length and alveolar bone height of the central incisor and the lateral incisor between genders, $p > 0.05$
Comparison of root length and alveolar bone height of the canine between genders, $p < 0.05$

geal space, the deep lobe of the parotid gland and skull base is difficult to exposure and manipulation because they are obscure locations[13]. The proper surgical approach is important for a successful operation[13]. In an ideal surgical approach, wide exposure, less damage to the normal tissues, convenience for hemostasis and reconstruction of the defect, radical resection of the tumor and less postoperative deformity are necessary[13]. The sufficient exposure and free access to the lesion may be hard to do along with good preservation of important anatomical structures in the adjacent regions[1,8,14]. The surgeon should preserve as much function as possible.

In the midline mandibulotomy, the genioglossus, geniohyoid, anterior belly of digastric and mylohyoid muscles have to be transected[1,2]. The paramidline mandibulotomy minimizes trauma to the midline muscles and only the transection of the mylohyoid muscle is required[8]. Transection of the genioglossus and geniohyoid muscles may cause difficulties in deglutination, suction and swallowing[14]. Therefore, the paramidline mandibulotomy should be a better function-preserving operation than the midline mandibulotomy[14]. Another disadvantage of the midline mandibulotomy is that the approach, in many cases, requires the extraction of a central incisor to prevent iatrogenic damage to the adjacent incisor root. The removal of a central incisor during midline mandibulotomy is not only cosmetically bothersome but may create difficulties in the closure of gingival tissue over the extracted socket area and may expose the bone and subsequently bone necrosis or osteoradionecrosis after radiation therapy[9,14].

The bone cut of the paramidline mandibultomy located between the lateral incisor and the canine is a relatively reasonable approach and not without problems[9, 14]. It still causes unequal muscular pull on the two segments of the mandible. If rigid and stable fixation cannot be achieved, mandibular nonunion will develop[14]. The clinical observation indicated that there was no significant difference in the mandibulotomy-related complication rate between midline and paramidline mandibulotomies[14], but the latter seems to offer some theoretical advantages[8,14]. The osteotomy site of paramidline mandibulotomy is often located over the margin of irradiation portals. Irradiation may interfere with collagen synthesis and wound healing and may result in a chronic nonhealing wound, nonunion or osteoradionecrosis. However, the effects of radiation on the osteotomy site are still controversial[15].

Pan et al[9] was the first group to report the angles and the horizontal distances between the M and between the PM of 50 Taiwanese patients with oral and oropharyngeal carcinomas. Later, Shohat et al[10] studied the same parameters in 100 radiographs of healthy patients who were referred for wisdom tooth extraction. Both studies were performed by using panoramic radiographs that were with lower image quality and more enlargement than periapical radiographs[11,12]. The present study was performed in 216 periapical radiographs of mandibular anterior teeth from 72 Thai dental patients (30 males and 42 females) without carcinomas by using the paralleling technique. In addition, there are some limitations in measuring a distance or angle by the naked eye with the ruler and protractor[16]. The smallest scale of the measuring device, which is a millimeter for linear and degree for angular measurement, limits the precision. It is evident that computers can make linear and angular measurements with high degree of precision, which is not possible by the traditional method. Therefore, com-

puterized image analysis was used in the present study. The radiographs were scanned at a resolution of 600 dpi to get the good image quality. It has been reported that the image quality of a cephalogram scanned at a resolution of 300 dpi is sufficient for clinical purposes and comparable to original analog cephalometrics[17].

The data of angles and the distances between the M and the PM of the present study differ from previous studies[9,10]. This may be due to the differences in radiographic technique. Additionally, other factors including method of study, ethnicity, age, and dental status should be kept in consideration. However, in the present study, the lower convergent angles as well as the wider horizontal distances were between the PM rather than those between the M, providing a safe cut of the mandible. The results of the present study support those of previous observations in other racial populations[9,10].

Furthermore, gender differences were also investigated in the present study and found no significant differences between these angles and the horizontal distances between genders ($p > 0.05$), except those at the crest level of the right PM and the left PM ($p < 0.05$).

In the present study, it was also found that the differences between the root length and the alveolar bone height of all measurements were no more than three mm, which indicated the normal periodontal status of all subjects studied. In addition, there were no significant differences in the root lengths and the alveolar bone heights between genders, except those of the canine ($p < 0.05$). The mean alveolar bone height of the canine is 15.88 ± 1.72 mm. Thus, in a paramidline mandibulotomy, the vertical alveolar bone cut should be at least 16 mm in length to prevent iatrogenic injury of the tooth root if the lower notched osteotomy is performed.

The paramidline mandibulotomy provides wider spaces of bone cut than that of the midline mandibulotomy. Therefore, it is one of the best alternative operative sites for the osteotomy in most cases of the fully dentate patient. It should be kept in mind that the angle and horizontal distances between the teeth in the paramidline mandibulotomy are still narrow. Individual cases should be carefully evaluated with a preoperative dental assessment, including periapical radiograph, panoramic radiograph and computed tomography to provide dental anatomy, location of mental foramen and anterior loop of mental foramen. Preoperative dental assessment has facilitated better occlusion postoperatively in dentate patients[8].

In conclusion, the present study provides dimensions of the anterior mandible containing anterior teeth by measuring the periapical radiographs, which may be useful for midline and paramidline mandibulotomy. The data support the previous concept of paramidline mandibulotomy in which bony cuts are performed through a wider gap, thus giving a higher chance for the surgeon to avoid the extraction of a central incisor and preserve the origin of the genioglossus, geniohyoid, and anterior belly of digastric muscles and leading to minimize postoperative functional complications.

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References

1. Spiro RH, Gerold FP, Strong EW. Mandibular "swing" approach for oral and oropharyngeal tumors. Head Neck Surg 1981; 3: 371-8.
2. Spiro RH, Gerold FP, Shah JP, Sessions RB, Strong EW. Mandibulotomy approach to oropharyngeal tumors. Am J Surg 1985; 150: 466-9.
3. Carrau RL, Myers EN, Johnson JT. Management of tumors arising in the parapharyngeal space. Laryngoscope 1990; 100: 583-9.
4. Hsu MM, Ko JY, Sheen TS, Chang YL. Salvage surgery for recurrent nasopharyngeal carcinoma. Arch Otolaryngol Head Neck Surg 1997; 123: 305-9.
5. Baker DC, Conley J. Surgical approach to retromandibular parotid tumors. Ann Plast Surg 1979; 3: 304-14.
6. Krespi YP, Sisson GA. Transmandibular exposure of the skull base. Am J Surg 1984; 148: 534-8.
7. Butlin HT. Diseases of the tongue. Clinical manuals for practitioners and students of medicine. London: Cassell; 1885: 1-331.
8. Dubner S, Spiro RH. Median mandibulotomy: a critical assessment. Head Neck 1991; 13: 389-93.
9. Pan WL, Hao SP, Lin YS, Chang KP, Su JL. The anatomical basis for mandibulotomy: midline versus paramidline. Laryngoscope 2003; 113: 377-80.
10. Shohat I, Yahalom R, Bedrin L, Taicher S, Talmi YP. Midline versus paramidline mandibulotomy: a

radiological study. Int J Oral Maxillofac Surg 2005; 34: 639-41.
11. Akesson L, Rohlin M, Hakansson J. Marginal bone in periodontal disease: an evaluation of image quality in panoramic and intra-oral radiography. Dentomaxillofac Radiol 1989; 18: 105-12.
12. Akesson L, Hakansson J, Rohlin M. Comparison of panoramic and intraoral radiography and pocket probing for the measurement of the marginal bone level. J Clin Periodontol 1992; 19: 326-32.
13. Yu GY, Zhang L, Guo CB, Huang MX, Mao C, Peng X. Pre-mental foramen mandibulotomy for resecting tumors of tongue base and parapharyngeal space. Chin Med J (Engl) 2005; 118: 1803-7.
14. Dai TS, Hao SP, Chang KP, Pan WL, Yeh HC, Tsang NM. Complications of mandibulotomy: midline versus paramidline. Otolaryngol Head Neck Surg 2003; 128: 137-41.
15. Amin MR, Deschler DG, Hayden RE. Straight midline mandibulotomy revisited. Laryngoscope 1999; 109: 1402-5.
16. Chen SK, Chen YJ, Yao CC, Chang HF. Enhanced speed and precision of measurement in a computer-assisted digital cephalometric analysis system. Angle Orthod 2004; 74: 501-7.
17. Ongkosuwito EM, Katsaros C, van't Hof MA, Bodegom JC, Kuijpers-Jagtman AM. The reproducibility of cephalometric measurements: a comparison of analogue and digital methods. Eur J Orthod 2002; 24: 655-65.

มิติสำหรับการผ่าตัดขากรรไกรล่างในแนวกลางและแนวใกล้กลาง: การศึกษาทางภาพรังสีในคนไทยที่มีฟัน

วันดี อภิณหสมิต, สุนทรา พันธ์มีเกียรติ, ศรุตา แสงทิพย์บวร, ศุทธินี อิทธาถิรุธ

***ภูมิหลัง**: การผ่าตัดขากรรไกรล่างเป็นวิธีการผ่าตัดที่สำคัญเพื่อเป็นทางเข้าไปสู่ช่องปาก คอหอยส่วนปากและช่องรอบคอหอย*

***วัตถุประสงค์**: ศึกษามิติสำหรับการผ่าตัดขากรรไกรล่างในแนวกลาง (ระหว่างฟันตัดซี่กลางสองซี่) และใกล้กลาง (ระหว่างฟันตัดซี่ข้างกับฟันเขี้ยว)*

***วัสดุและวิธีการ**: ศึกษาภาพรังสีรอบปลายรากฟันหน้าล่างจำนวน 216 ภาพจากผู้ป่วยทันตกรรมที่เป็นคนไทยจำนวน 72 ราย (ชาย 30 ราย และหญิง 42 ราย) โดยการวัดมุมระหว่างแนวแกนของฟันตัดซี่กลางสองซี่และระหว่างฟันตัดซี่ข้างกับฟันเขี้ยวทั้งสองข้าง และวัดระยะในแนวราบระหว่างฟัน (ระดับสันกระดูกเบ้าฟัน กลางรากฟัน และปลายรากฟัน) รวมทั้งวัดความสูงของกระดูกเบ้าฟัน ด้วยโปรแกรมคอมพิวเตอร์*

***ผลการศึกษา**: มุมระหว่างฟันตัดซี่ข้างกับฟันเขี้ยว (0.00-9.26 องศา) สอบเข้าหากันน้อยกว่ามุมระหว่างฟันตัดซี่กลางสองซี่ (0.00-11.66 องศา) ($p < 0.05$) ระยะในแนวราบระหว่างฟันตัดซี่ข้างกับฟันเขี้ยว มีค่าเท่ากับ 0.60-8.03 มม. ในขณะที่ระยะในแนวราบระหว่างฟันตัดซี่กลางสองซี่มีค่าเท่ากับ 0.47-6.63 มม. ($p < 0.05$) และความสูงของกระดูกเบ้าฟันเขี้ยวมีค่าเฉลี่ยเท่ากับ 15.88 $\pm$ 1.72 มม.*

***สรุป**: การผ่าตัดขากรรไกรล่างในแนวใกล้กลางจะทำในบริเวณที่กว้างกว่าการผ่าตัดในแนวกลาง และทำให้ศัลยแพทย์หลีกเลี่ยงการถอนฟันตัดซี่กลางได้มากขึ้น อีกทั้งจะไม่ทำลายที่เกาะต้นของกล้ามเนื้อเจนิโอฮัยออยด์ กล้ามเนื้อเจนิโอกลอสซัส และกล้ามเนื้อไดแกสทริก*