ORIGINAL ARTICLE

Anatomical Study of the Mandibular Canal: The Safe Surgical Landmarks for Mandibular Contouring Surgery

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Received on: 14 August 2022; *Accepted on:* 28 May 2023; *Published on:* 09 January 2024

Abstract

Background: Mandibular contouring surgery is a common facial plastic surgery in Asia. The aim of this study was to evaluate the course of intraosseous inferior alveolar nerve within the mandibular canal in Thai population through three-dimensional computed tomography (CT) to find the safe surgical landmarks for mandibular contouring surgery.

Materials and methods: This was a retrospective study in 200 patients who underwent computed tomographic assessment of head and neck region at the Faculty of Medicine, Ramathibodi Hospital, Mahidol University from January 2010 to December 2015. The inferior alveolar nerve was identified and traced along the mandibular canal from a three-dimensional image slice, and then the reconstruction of 3D images was performed. The oblique line, the alveolar arch line, the gonion, and O point were identified. Afterwards, the horizontal, oblique, and vertical distances were defined and measured. Comparison of these distances between each side was also analyzed.

Results: The mandibular canal was far away from the posterior border of ramus for 17.58–17.62 mm in male, and 15.61–15.68 mm in female. It was far away from the gonion for 25.67–25.75 mm in male, and 22.73–22.77 mm in female. It was far away from the inferior border of mandibular body for 16.62–16.78 mm in male, and 15.75–15.84 mm in female. The statistical analysis showed no significant difference in all distances between each side in both male and female groups.

Conclusion: A safe surgical landmark for angle mandible reduction is at a width less than 25 mm from the gonion in Thai men and 22 mm in Thai women.

Keywords: Mandibular canal, Mandible, Mandibular contouring surgery, Mandibular angle reduction.

Otorhinolaryngology Clinics: An International Journal (2023): 10.5005/jp-journals-10003-1478

Introduction

Prominent mandibular angle which makes a characteristic of square and muscular appearance is a common problem encountered in Asian facial plastic surgery. This deformity can be accompanied with other causes such as masseteric hypertrophy from mainly unilateral side clenching, bruxing, or chewing for such a time.[1,2]

Nowadays, a square-shaped face is considered undesirable among Asian populations. Many people believe that it erodes self-image. Therefore, these patients often come to a hospital for surgical reduction of mandibular angles to create an ovoid-shaped face, which is considered charming in Asian's belief.

Mandibular contouring surgery is a common facial plastic surgery in Asia, especially in women.[3–14] The surgeon's goal is to do angle mandible resection without injuring the inferior alveolar nerve during surgery. The path of the inferior alveolar nerve has been marked by conventional radiographs for preoperative planning. However, in the present days, three-dimensional computed tomography (CT) has been used commonly to determine the position of inferior alveolar nerve position instead of the cephalometric or panoramic radiograph.[15]

The mandibular nerve is a third branch of trigeminal nerve. The inferior alveolar nerve which is a branch of the mandibular nerve enters the mandibular foramen within the mandible and exits at mental foramen. Injuring the nerve most commonly occurs in maxillofacial fractures, orthognathic surgery, surgery of the wisdom tooth, and lower jaw dental implant procedures. This will cause the loss of sensation and/or pain or abnormal sensation around the lower gum, lower lip, and chin. These symptoms can cause impact on quality of life.

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How to cite this article: Tungkeeratichai J, Leelapatharaphan N, Iamsudjai Y, *et al*. Anatomical Study of the Mandibular Canal: The Safe Surgical Landmarks for Mandibular Contouring Surgery. Int J Otorhinolaryngol Clin 2023;15(3):128–131.
Source of support: Nil
Conflict of interest: Dr Jumroon Tungkeeratichai is associated as the Editorial board members of this journal and this manuscript was subjected to this journal's standard review procedures, with this peer review handled independently of these Editorial board members and their research group.

In the recent years, more of Thai patients are interested in mandibular angle resection surgery. The purpose of this paper was to use three-dimensional CT to define the course of inferior alveolar nerve which is lined in the mandibular canal in Thai population so as to find the safe surgical landmark for mandibular contouring surgery.

Materials and Methods

This study was approved by the Committee on Human Rights related to Research Involving Human Subjects, Faculty of

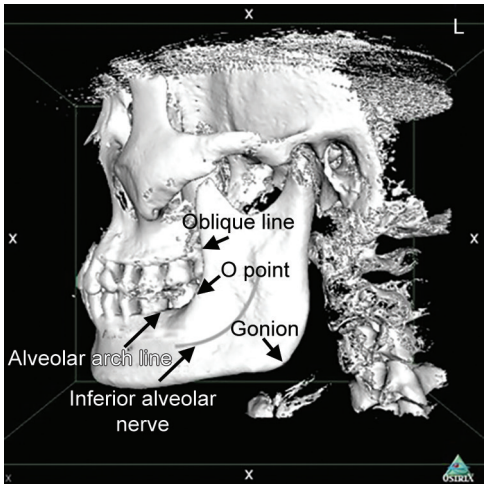

Fig. 1: A three-dimensional CT image shows the inferior alveolar nerve course, the oblique line, the alveolar arch line, the gonion, and O point which are the landmarks of interest

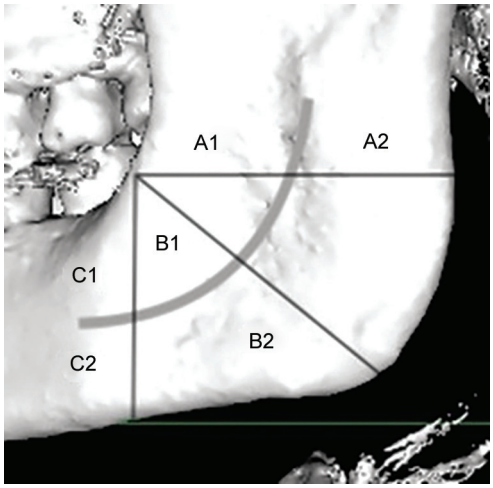

Fig. 2: A three-dimensional CT image shows A1, A2, B1, B2, C1, C2 distances. These distances are the interested parameters which are used for data analysis

Medicine, Ramathibodi Hospital, Mahidol University, Thailand. This study was a retrospective review of 200 patients aged 18–60 years who underwent head and neck evaluation with computed tomographic study at Faculty of Medicine Ramathibodi Hospital, Mahidol University from January 2010 to December 2015. The patients with mandibular fractures, tumors in oral cavity with mandibular involvement, osteoporosis, congenital conditions, edentulous tooth or teeth, and previous surgery of the mandible were excluded from the study.

Raw computed tomographic data were collected from the database of Department of Radiology, Faculty of Medicine Ramathibodi Hospital, Mahidol University. All the CT images were generated under a standard head and neck protocol with 0.625 mm thickness for each slice in three dimensions (Axial, coronal, and sagittal views). OsiriX software version 10.0.5 was used for developing digital image and measurement. At first, CT images were meticulously adjusted for the best visualization. Then, the inferior alveolar nerve was identified along the mandibular canal using three-dimensional image slice. The nerve was marked from the entry site to the end at mental foramen. The nerve was marked with gray color in each slice along the mandibular canal. Afterward, reconstruction of three-dimensional (3D) image was performed after complete nerve tract identification.

Lun Jou Lo et al.[16] previously conducted a study to evaluate the inferior alveolar nerve position comparing between prominent mandibular angle patients and normal Taiwanese patients. However, this study aimed to evaluate whether such findings can be applied in Thai population.

From Figure 1 the oblique line is the vertical line that extends along the anterior cortex of ramus the mandible. The alveolar arch line is the horizontal line of the alveolar crest of mandible. Therefore, the O point is the point which the oblique line and alveolar arch line are intersected. The gonion is the lowest posterior and most outward point of the angle of the mandible.

Subsequently, linear distances were defined and measured as Figure 2. This shows the A1, A2, B1, B2, C1, and C2 distances. These distances are the interested parameters which are used for data analysis. There are three planes from O point which are horizontal plane, oblique plane, and vertical plane. The horizontal plane from the O point to a point on the cortical surface overlying the inferior alveolar nerve is measured as A1, and continue the horizontal plane from this point of inferior alveolar nerve to a point of the posterior border of ramus is measured as A2. The oblique plane which is 45 degrees from the horizontal plane. The oblique plane from the O point to a point on the cortical surface overlying the inferior alveolar nerve is measured as B1, and from this point of inferior alveolar nerve to the gonion is measured as B2. Finally, the vertical plane which is 90 degrees from the horizontal plane. The distance from the O point to a point on the cortical surface overlying the inferior alveolar nerve is measured as C1, and from this point of inferior alveolar nerve to a point of the inferior border of mandibular body is measured as C2 (Fig. 2).

In this study, all the CT images were processed and measured by the same radiologist and software. Stata/SE14.1 (Stata Corp, Texas) was used for statistical analysis. Comparison of the distances between each side was performed using *t*-test. Significant level was considered when *p*-value was less than 0.05.

Results

There were 200 patients, or 400 hemimandibles, included in this study. The patients consisted of 100 males with a mean age of 34.27 ± 8.40 years, and 100 females with a mean age of 32.61 ± 8.25 years. All of the CT images demonstrated all the landmarks and distances of interest. The distances of interest in both male and female were demonstrated in Table 1. Moreover, the statistical analysis showed no significant difference in the horizontal distance, the oblique distance, and the vertical distance between each side in both male and female groups (Table 1).

Mandibular contouring surgery is a common facial plastic surgery in Asia, especially in women.[3–14] Since inferior alveolar nerve injury may lead to temporary or persistent numbness of the lower lip, precise localization of the inferior alveolar nerve and avoid injurying the nerve is an important step along the mandibular angle reduction procedures.

There have been several anatomic studies of the inferior alveolar nerve course or the mandibular canal in both cadavers and radiographs for dacades.[17–26]

Table 1: Linear distances measured on the mandibular angle in relation to the course of inferior alveolar nerve

	Male			*Female*		
Measurement	*Left (mm)*	*Right (mm)*	*p-value*	*Left (mm)*	*Right (mm)*	*p-value*
Horizontal distance						
A1	22.01 ± 2.64	21.98 ± 2.72	0.12	21.14 ± 2.54	21.23 ± 2.61	0.34
A2	17.62 ± 1.58	17.58 ± 1.64	0.35	15.68 ± 1.43	15.61 ± 1.56	0.24
A1 + A2	39.65 ± 3.12	39.58 ± 3.25	0.30	36.86 ± 2.97	36.87 ± 3.01	0.16
Oblique distance						
B1	15.67 ± 2.21	15.82 ± 2.56	0.62	14.83 ± 2.31	14.79 ± 2.27	0.23
B2	25.75 ± 2.45	25.67 ± 2.34	0.34	22.73 ± 3.12	22.77 ± 3.08	0.20
B1 + B2	41.41 ± 4.13	41.51 ± 4.54	0.42	37.58 ± 5.06	37.57 ± 4.97	0.20
Vertical distance						
C1	21.12 ± 2.01	21.07 ± 1.99	0.29	20.56 ± 2.21	20.73 ± 2.08	0.56
C2	16.78 ± 2.54	16.62 ± 2.62	0.19	15.75 ± 2.43	15.84 ± 2.15	0.40
C1 + C2	37.88 ± 4.32	37.71 ± 4.45	0.32	36.25 ± 4.41	36.49 ± 4.01	0.47

In recent years, CT has been used to track the inferior alveolar nerve in the maxillofacial surgery especially the three-dimensional (3D) assessment. A previous study examined formalin-fixed hemimandible specimens from human cadavers.[27] Various distances of the hemimandible specimens were measured both by CT measurements and digital caliper measurements. Comparing two methods of measurement, there were high agreement between CT and digital caliper measurements. The result of the study suggested that CT was a reliable tool for the presurgical measurement of the inferior alveolar nerve in the mandibular canal region.

A study from Massey et al.[28] determined the accuracy of CT for inferior alveolar nerve position in the mandibular canal of hemimandibles of the cadavers. They measured the bone thickness surrounding the nerve compared by digital caliper and CT. The result also showed high consistency between two methods.[28] The study concluded that CT has been a crucial tool to locate the inferior alveolar nerve during placement of dental implants.

There have been no data or previous study regarding the anatomy of the mandibular canal in Thai patients. Therefore, the purpose of this study is to use CT to define the course of inferior alveolar nerve in Thai population. This will provide some useful data collected from three-dimensional CT which help the surgeons perform angle mandible reduction procedures successfully without complications.

From our study, the mandibular canal was far away from the posterior border of ramus for 17.58–17.62 mm in male, and 15.61–15.68 mm in female. In addition, it was far away from the gonion for 25.67–25.75 mm in male, and 22.73–22.77 mm in female. Moreover, it was far away from the inferior border of mandibular body for 16.62–16.78 mm in male, and 15.75–15.84 mm in female. The statistical analysis showed no significant difference in all distances between each side in both male and female groups (Table 1).

The resection line should be placed below the mandibular canal. Our finding shows from CT measurements in determining the position of the inferior alveolar nerve in Thai population. Our study recommends a safe surgical landmark for angle mandible reduction at a width less than 25 mm from the gonion in Thai men and 22 mm in Thai women.

According to a study in Japan, the author performed and collected data from 44 patients who had undergone intraoral approach resecting the prominent mandibular angle. With their surgical techniques, the mandibular angle was resected by a width of 10–15 mm. After surgery, there were no mandibular fractures or nerve injuries in all their patients.[11]

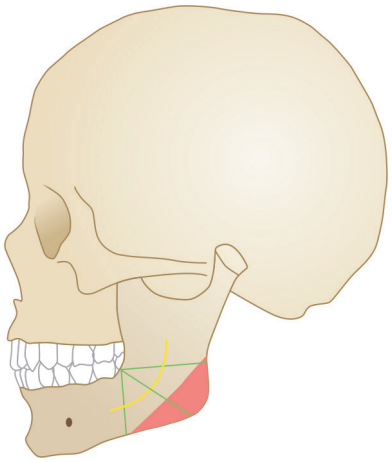

Fig. 3: The red line is the line of angle mandible resection. The yellow line is the mandibular canal

From our experience in the operating room, we usually resect the width not more than 15 mm from the angle to prevent inferior alveolar nerve injury. According to our study, the line of resection (red line) is about 60% of the distance from the angle of mandible to inferior alveolar nerve position. (Fig. 3) There is still a safe zone that keeps the resection away from the nerve.

Conclusion

A safe surgical landmark for angle mandible reduction is at a width less than 25 mm from the gonion in Thai men and 22 mm in Thai women.

Acknowledgments

The authors would like to take this opportunity to thank Dr Worranan Prasanatikom and Prof Amnuay Thithapandha, Faculty of Medicine,

Ramathibodi Hospital, Mahidol University for contribution of the analysis and advice to the preparation of this manuscript.

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