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ORIGINAL ARTICLE

Cephalometric Prediction of Risk Factors for Mandibular Third Molar Impaction

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Background: Mandibular third molar impaction in adult patients is one of the most common problems in dental practice. However, limited data are available on the association between mandibular third molar impaction and craniofacial skeletal problems. **Aim:** This study aimed to establish a prediction model to evaluate the risk factors for mandibular third molar impaction. **Methods:** Panoramic and lateral cephalometric radiographs of orthodontic patients aged ≥20 years were obtained from the Tri-Service General Hospital. The radiographs were analyzed by a single examiner. Panoramic radiographs were used to evaluate the mandibular third molar impaction. Lateral cephalometric radiographs were used to evaluate five linear and six angular measurements to define the facial pattern of the participants. The association between cephalometric measurements and mandibular third molar impaction was determined using one-way analysis of variance and logistic regression analysis. **Results:** This study included 60 participants. The incidence of mandibular third molar impaction was associated with the mandibular plane angle (MPA) and mandibular length (Co-Gn) ($P < 0.001$). The presence of mandibular third molar impaction was found to gradually increase with increasing MPA and decreasing mandibular length. **Conclusion:** Individuals with a greater MPA and lesser mandibular length had a higher incidence of mandibular third molar impaction.

Key words: Cephalometric prediction, logistic regression, mandibular length, mandibular plane angle, mandibular third molar impaction

INTRODUCTION

Mandibular third molar impaction in adult patients is one of the most common problems in dental practice. Impaction of the third molars is more common in the mandible than in the maxilla.[1-4] The prevalence of mandibular third molar impaction is approximately 27%–68.6%, which is relatively common in the studied population.[5-7] For maxillary and mandibular third molar impaction, no significant difference was noted between the left and right sides.[2,4,6] In addition, eruption of the third molar can be hindered by many factors that can be divided into two major categories: loss of space or obstruction.[8,9]

Retromolar space deficiency is a considerable etiology of mandibular third molar impaction.[8,10,11] Inadequate retromolar space is related to inadequate mandibular growth.[1] However, the relationship between impaction of the lower third molar and some skeletal or dental characteristics is controversial and varies among different populations.[12] Some studies[8,13] have shown that mandibular length is an influential factor in the eruption of mandibular third molars. However, others[14,15] claimed that no significant difference was found between the mandibular length and eruption of the mandibular third molars. Hence, the relationship between mandibular length and mandibular third molar impaction has been debated and

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remains controversial. In addition, researchers have attempted to create pretreatment parameters to predict eruption or impaction of the lower third molars with inconclusive results.[13,16]

A few studies have concentrated on the Taiwanese population to discuss the association between craniofacial growth patterns and mandibular third molar impactions. This study aimed to establish a prediction model to evaluate the risk factors for mandibular third molar impaction.

MATERIALS AND METHODS

Dental radiographs were obtained from 60 patients (26 men and 34 women) with a mean age of 24.5 years, who visited the Division of Orthodontics, Department of Dentistry, Tri-Service General Hospital, between 2018 and 2020. Ethical approval was obtained from the Institutional Review Committee of Tri-Service General Hospital (IRB number: C202105201). The patient consent was obtained. The inclusion criteria for this study were as follows: the pretreatment radiography of participants with the existence of the mandibular third molars with at least two-third of root formation completed, the mandibular third molars were either fully erupted or impacted, no maxillofacial trauma history, no previous orthodontic treatment, and no missing or extraction of permanent teeth. The exclusion criteria were mandibular third molars with pathological lesions such as cystic lesions or large caries and patients with endocrine dysfunction or craniofacial abnormalities.

Digital panoramic and lateral cephalometric radiography (Asahiroentgen machine, Hyper-G model, Japan, with a tube voltage of 90 Kv, maximum) were used. Standard panoramic exposures were performed using a standard protocol. One examiner checked all the radiographs (panoramic [Figure 1] and lateral cephalometric [Figure 2] films) and performed the following radiographic measurements. The classification of full eruption or impaction of the mandibular third molar was defined by the Pell and Gregory's classification system and the National Health Insurance Administration Ministry of Health and Welfare in Taiwan. The mandibular third molars with position A and Class I classification and without soft tissue covering were defined as full eruptions. Others with soft tissue covering were defined as mandibular third molar impactions. The subjects were divided into three groups according to no, unilateral, and bilateral mandibular third molar impaction. Lateral cephalometric radiographs were obtained to determine the clinical outcomes. The analysis consisted of the following: angular measurements (SNA, SNB, ANB, SN-MP, U1 to SN, and L1 to MP) [Figure 3] and linear measurements (U1 to NA, L1 to NB, upper E-line, lower E-line, and mandibular length) [Figure 4]. Moreover, the definitions of the cephalometric variables were measured as follows:

- SNA (angle between sella, nasion, and subspinale point A)
- SNB (angle between sella, nasion, and supramentale point B)
- ANB (angle between the maxilla and the mandible)
- SN-MP (angle between sella-nasion plane and mandibular plane)
- U1 to SN (angle between maxillary incisor and sella-nasion plane)
- L1 to MP (angle between mandibular incisor and mandibular plane)
- U1 to NA (distance from maxillary incisor tip to nasion-subspinale point A line)
- L1 to NB (distance from mandibular incisor tip to nasion-supramentale point B line)
- Upper E-line (distance from upper lip to esthetic line of Ricketts [Pn to Pog'])
- Lower E-line (distance from lower lip to esthetic line of Ricketts [Pn to Pog'])
- Co-Pog (amount of mandibular length).

Statistical analysis

SPSS Statistics (22.0 version for Windows, SPSS, Inc.,

Figure 1: Panoramic radiography

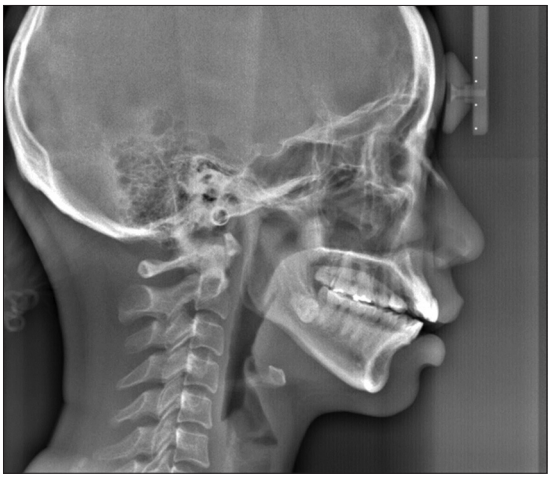

Figure 2: Cephalometric radiography

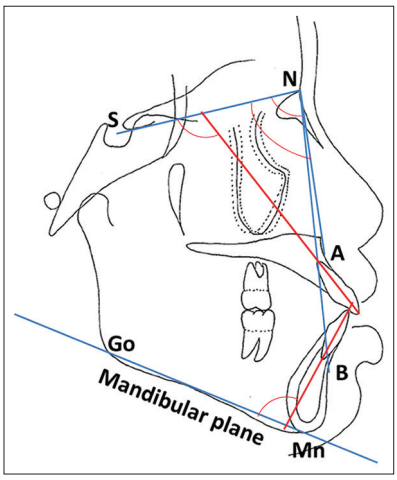

Figure 3: Angular measurements in cephalometric radiography

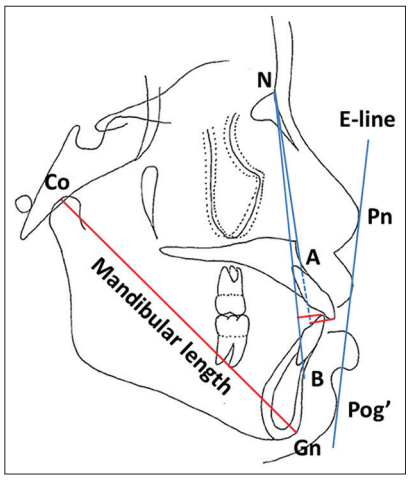

Figure 4: Linear measurements in cephalometric radiography

Chicago, IL) was used for statistical analyses. Two-tailed $P<0.05$ was considered statistically significant. First, we applied a one-way analysis of variance to evaluate the relationship between cephalometric measurements and mandibular third molar impactions. Furthermore, an extended model covariate adjustment was used, which was adjusted for age. Continuous variables representing cephalometric measurements, such as the SN-MP angle and mandibular length, were analyzed to assess the effect of cephalometric measurements on the presence of mandibular third molar impaction. The cutoff SN-MP angle and mandibular length to calculate the *P* values for the trends of the quartiles were as follows: (1) SN-MP°: Q1 <30.05°, 30.06 ≤ Q2 <34.50°, 34.51 ≤ Q3 <38.62°, and Q4 ≥38.63° and (2) mandibular length: Q1 < 106.7 mm, 106.8 ≤ Q2 <111.4 mm, 111.5 ≤ Q3 <118.0 mm, and Q4 ≥118.1 mm. We also investigated two types of correlations: (1) SN-MP angle changes and mandibular third molar impaction and (2) mandibular length changes and mandibular third molar impaction using logistic regression analysis.

RESULTS

Characteristics and demographic data

Table 1 shows the characteristics and demographic data of the 60 participants. Data were obtained from the Tri-Service General Hospital, and the investigated variables of the included patients were measured in this analysis. All the investigated variables included age, sex, SNA, SNB, ANB, SN-MP, U1 to SN, L1 to MP, U1 to NA, L1 to NB, upper E-line, lower E-line, and mandibular length. The frequency of participants was 17, 19, and 24 with no (Group A), unilateral (Group B), and bilateral (Group C) mandibular third molar impactions, respectively. The incidence of impacted mandibular third molars was associated with age, mandibular plane angle (MPA), and mandibular length ($P < 0.05$).

Mandibular third molar impaction and cephalometric analysis

The logistic regression analysis [Table 2] shows the comparison of the MPA and mandibular length values based on the presence of mandibular third molar impaction. Adjustments for age were also assessed. In the unadjusted model, a significant association was observed between the MPA and the presence of mandibular third molar impaction (β-coefficient = 0.219, odds ratio [OR] =1.244, and $P = 0.001$). However, a significant reverse association was observed between mandibular length and the presence of mandibular third molar impaction (β-coefficient = −0.092, OR = 0.912, and $P = 0.009$). After considering the quartile of MPA and mandibular length in the unadjusted and adjusted models, all trends had $P < 0.05$.

DISCUSSION

This study analyzed 60 participants with or without impacted mandibular third molars to investigate the association between cephalometric analysis and mandibular third molar impaction using cephalometric and panoramic radiography. It revealed that the incidence of impacted mandibular third molars significantly increased with an increasing MPA and decreasing mandibular length. After adjusting for age, the incidence of impacted mandibular third molar was prominent in participants with a higher MPA. However, a lower incidence of impacted mandibular third molars was observed in participants with a longer mandibular length.

Mandibular third molar impaction is mainly influenced by space discrepancy in the dental alveolar arch between

Table 1: characteristics and demographic data of 60 participants

Variables	Group A (*n*=17) Mean (SD)	Group B (*n*=19) Mean (SD)	Group C (*n*=24) Mean (SD)	*P*	Multiple test comparisons								
					A vs B			B vs C			A vs C		
					Mean diff	SE	Corr. *P*	Mean diff	SE	Corr. *P*	Mean diff	SE	Corr. *P*
Age (year)	27.53±6.40	26.05±5.20	21.08±3.37	<0.001*	1.48	1.66	0.674	4.97	1.52	0.008**	6.45	1.57	0.001**
Male %	38.5	23.1	38.5	0.252									
SNA°	83.6±3.21	82.3±3.55	81.5±3.50	0.180	1.25	1.15	0.556	0.8	1.05	0.752	2.05	1.09	0.18
SNB°	82.1±3.70	78.6±5.51	78.7±4.63	0.042	3.54	1.57	0.087	-0.10	1.44	0.997	3.44	1.49	0.078
ANB°	1.43±2.71	3.72±4.10	2.86±3.83	0.174	-2.29	1.22	0.179	0.86	1.12	0.748	-1.44	1.16	0.466
SN-MP°	30.4±5.32	36.2±4.43	36.3±6.38	0.002*	-5.83	1.85	0.010*	-0.01	1.70	1	-5.84	1.75	0.006**
U1 to NA (mm)	8.61±3.056	7.05±2.53	7.41±2.92	0.237	1.56	0.95	0.106	-0.36	0.87	0.683	1.20	0.90	0.188
U1 to SN°	112.9±8.65	107.7±6.60	110.1±8.89	0.168	5.23	2.72	0.168	-2.36	2.51	0.644	2.86	2.59	0.545
L1 to NB (mm)	8.35±2.93	8.64±3.30	8.3±3.08	0.929	-0.30	1.04	0.959	0.35	0.96	0.936	0.05	0.99	0.999
L1 to MP°	98.0±8.04	94.9±10.58	96.2±7.24	0.573	3.05	2.88	0.575	-1.25	2.65	0.896	1.82	2.74	0.806
E-line (U)	0.05±2.32	0.82±3.37	1.01±3.28	0.596	-0.78	1.03	0.752	-0.19	0.94	0.980	-0.97	0.97	0.614
E-line (L)	2.89±3.57	3.02±2.83	3.53±2.84	0.772	-0.13	1.02	0.992	-0.51	0.94	0.863	-0.64	0.97	0.805
Mandibular length	118.3±9.53	110.8±10.01	111±6.88	0.017*	7.46	2.91	0.045*	-0.16	2.68	0.998	7.30	2.77	0.037*

**P*<.05; ***P*<.01; diff, difference; SD: standard deviation; SE, standard error. *Mandibular third molar impaction; Group A=no; Group B=unilateral; Group C=bilateral.

the ascending ramus and mandibular second molar.[17,18] With mandibular growth, the space gradually increases.[17] The relationship between mandibular third molar impaction and various factors has been widely discussed. A study discussed the role of blood group in the presence of third molar impaction and showed that no relationship exists between the ABO blood grouping system and mandibular third molar impaction.[19] Regarding the impact of mandibular third molars and their association with age, older patients (>20 years) favor mandibular third molar eruption compared to younger participants.[20] In addition, some studies[8,13] showed that mandibular length influences the eruption of the lower third molars. However, others[14,15] claimed that no significant difference was found between the mandibular length and eruption of the mandibular third molars. To investigate the association between cephalometric measurements and lower third molar impaction, adjustment for covariates is necessary. The covariate of age was not adjusted in previous studies. In addition, logistic regression analysis was not performed to evaluate the incidence of lower third molars. Applying these, our study revealed that the incidence of lower third molar impaction increases significantly with an increase in the MPA. However, a reverse association was observed between the mandibular length and the presence of mandibular third molar impaction. Accordingly, it is essential to adjust for confounding factors, which could help us investigate the association and predictive value between lower third molar impaction and cephalometric measurements.[16]

This study had several limitations. First, a cause-and-effect relationship could not be generated between cephalometric measurements and mandibular third molar impaction as this was a cross-sectional study. Furthermore, the findings cannot be generalized because the study was conducted using a smaller sample.

The strength of this study includes statistical adjustments to eliminate confounding factors. In addition, this study extended the investigation to observe the association between the progressive increase in cephalometric measurements (MPA and mandibular length) and the incidence of mandibular third molar impactions.

CONCLUSION

This study highlighted that individuals with a greater MPA had a higher incidence of impacted mandibular third molars. However, individuals with greater mandibular length had a reverse effect on mandibular third molar impaction. This association can be considered in clinical practice. Nevertheless, the cross-sectional design of this study may not reveal the exact changes in this association. Hence, future prospective cohort studies are necessary for comprehensive evaluation.

Acknowledgments

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Table 2: Regression coefficients for SN-MP (°) and mandibular length (cm) in terms of the presence of mandibular third molar impaction

Variables	Unadjusted			Adjusted, age		
	β (SE)	OR (95% CI)	*P*	β (SE)	OR (95% CI)	*P*
SN-MP°	0.219 (0.072)	1.244 (1.080-1.434)	0.002*	0.198 (0.077)	1.219 (1.048-1.419)	0.010*
SN-MP° by quartile						
Quartile 1 (≤30.05)	Reference	Reference		Reference	Reference	
Quartile 2 (30.06-34.50)	0.922 (0.748)	2.514 (0.581-10.882)	0.217	0.913 (0.797)	2.492 (0.522-11.893)	0.252
Quartile 3 (34.51-38.62)	1.433 (0.832)	4.190 (0.821-21.399)	0.085	1.249 (0.866)	3.487 (0.639-19.028)	0.149
Quartile 4 (≥38.63)	2.773 (1.157)	16.00 (1.656-154.595)	0.017*	2.673 (1.205)	14.480 (1.363-153.771)	0.027*
P for trend		*P*=0.007*			*P*=0.030*	
Mandibular length, mm	-0.092 (0.035)	0.912 (0.852-0.977)	0.009*	-0.187 (0.064)	0.830 (0.733-0.940)	0.003*
Mandibular length, mm by quartile						
Quartile 1 (≤106.7)	Reference	Reference		Reference	Reference	
Quartile 2 (106.8-111.4)	0.000 (1.074)	1.000 (0.122-8.210)	1.000	-0.528 (1.187)	0.590 (0.058-6.034)	0.656
Quartile 3 (111.5-118)	-1.466 (0.925)	0.231 (0.38-1.413)	0.113	-1.713 (1.023)	0.180 (0.024-1.340)	0.094
Quartile 4(≥118.1)	-1.738 (0.919)	0.176 (0.029-1.065)	0.059	-2.709 (1.103)	0.067 (0.008-0.578)	0.014*
P for trend		*P*=0.001*			*P*=0.001*	

Data availability statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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Conflicts of interest

There are no conflicts of interest.

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