Transactions of the Illinois State Academy of Science
(2025) Volume 118, pp. 11-14

received 4/3/25
accepted 5/5/25

Does Mandible Development Influence Wisdom Tooth Impaction?

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ABSTRACT

This study examines whether mandible development influences impaction of the mandibular third molars (wisdom teeth), with a focus on the mandible length-to-height ratio, cranial length-to-mandible length ratio, and gonial angle (GA). Utilizing digitized cephalograms from the University of Toronto Burlington Growth Study, measurements were taken from 65 subjects (36 males, 29 females) over two longitudinal age groups: 7.0-9.3 years (age 1) and 15.9-21.0 years (age 2). The results found no significant difference in the GA between males and females at age 1, but a significant difference was found at age 2. Males showed changes in GA between the two age groups, while females did not. Between the age groups, both sexes exhibited significant differences in mandible length-to-height ratios. However, no significant differences were found in mandible length-to-height ratios or GA between individuals with impacted vs. non-impacted mandibular third molars. The study also assessed cranial length-to-mandible length ratios, which were found to be significantly different between ages 1 and 2 for both sexes. These findings suggest that while sexual dimorphism in mandible development becomes more distinct after puberty, it does not significantly influence the likelihood of mandibular third molar impaction. These results oppose previous assumptions that a larger gonial angle reduces the probability of third molar impaction, highlighting the complexity of factors involved in dental development.

INTRODUCTION

Understanding the development of the mandible and the prevalence of impacted mandibular third molars (wisdom teeth) is crucial for addressing the clinical indications for their extraction. Impacted mandibular third molars are a common occurrence, which can lead to various complications, including pain, infection, and damage to adjacent teeth (Hasan et al., 2016; Yu et al., 2022). Previous studies have found correlations between mandibular third molar impaction and various mandibular dimension and angle measurements (Barone et al., 2021). Other studies have found evidence of sexual dimorphism in impaction rates (Biswari et al., 1970; Ursi et al., 1993). The present study aims to expand upon previous research by assessing the relationship between mandibular dimensions, gonial angle (GA, also known as mandibular ramus angle or ramus angle), and the impaction of mandibular third molars in both males and females, providing insight into the factors influencing impaction rates and potential clinical implications.

Barone and colleagues (2021) assessed the correlation between GA and the frequency of mandibular molar impaction. They found a significant relationship, arguing that a lower GA is correlated with an increased rate of third molar impaction. The study also assessed the cranial length-to-mandible length ratio and found that an increase in this ratio is significantly correlated with a larger GA. Abuhiljeh et al. (2019) found significant sexual dimorphism in gonial angle (GA), with females having higher mean GA values compared to males.

Differences in craniofacial growth patterns between males and females have been argued to play a significant role in the frequency of mandibular third molar impaction (Biswari et al., 1970; Ursi et al., 1993). Biswari and colleagues (1970) found that females have a shorter window of bone growth compared to males, with males generally developing larger mandibles. Due to this growth pattern, it was argued that females are more likely to have insufficient space within the mandible for third molar development, placing them at higher risk of impaction (Biswari et al., 1970).

The cephalometric evaluation by Ursi and colleagues (1993) observed differences in craniofacial growth patterns between males and females from the Bolton-Brush Growth Study at ages 6, 9, 12, 14, 16, and 18 years. These observations showed that before the age of 14 years, both males and females had similar effective lengths of the maxilla and mandible. When re-evaluated at ages 14 to 18 years, the results showed that the male lengths increased while the female lengths remained relatively constant. This difference in growth pattern can influence the space available for mandibular third molar development and eruption, potentially affecting impaction rates (Ursi et al., 1993).

METHODS

All measurements were collected from digitized cephalograms from the University of Toronto Burlington Growth Study (Figs. 1, 2). The sample includes 65 total subjects (36 males, 29 females), each measured at two longitudinal age groups (age 1: 7.0 to 9.3 years, age 2: 15.9 to 21.0 years). Within this sample, 39 subjects showed mandibular third molar impaction, while 26 subjects did now show impaction. Subjects were selected using the following criteria: at least one clear, complete cephalogram was represented within each of the two selected age groups, and the subject developed at least one mandibular third molar (with or without impaction).

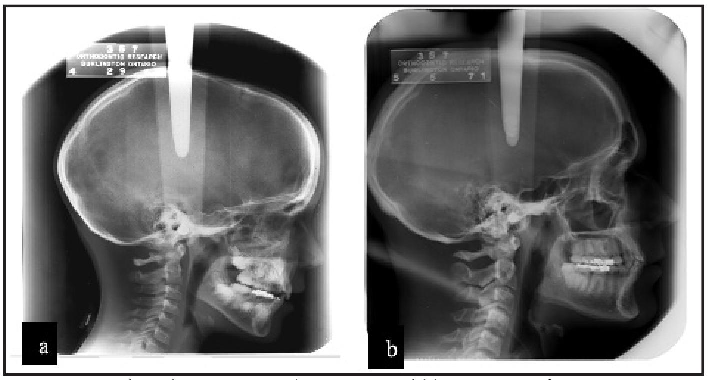

Figure 1. Male subject 357 at a) 9 years and b) 20 years of age.

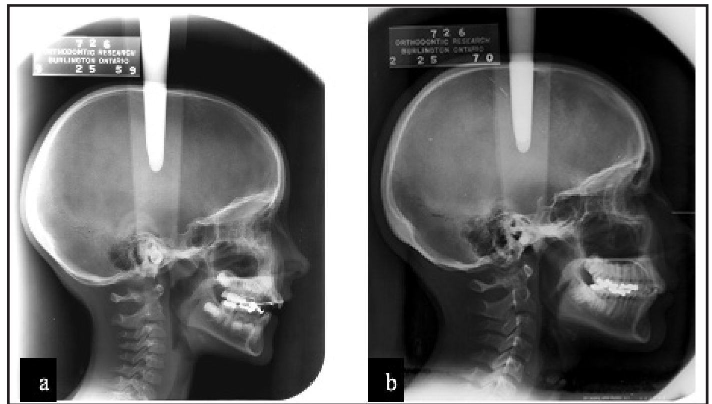

Figure 2. Female subject 726 at a) 8 years of age and b) 18.5 years of age.

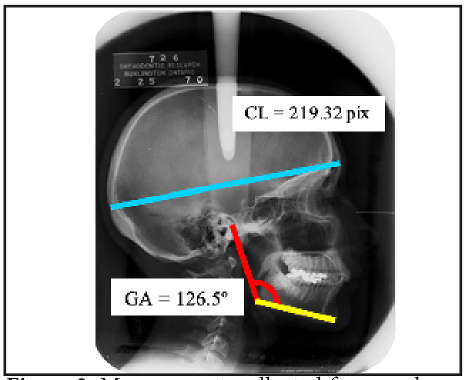

Figure 3. Measurments collected from each radiograph. GA (red). Cranial length (blue). Mandibular length (yellow).

Table 1. Male vs. female *t*-test results, including gonial angle (GA), mandible height-to-mandible length ratio (MH vs. L), and cranial length-to-mandible length ratio (CL vs. ML). Significant results are indicated with an asterisk.

	Age 1			Age 2		
	df	*t*	*p*-value	*df*	*t*	*p*-value
GA	63	1.07	0.2898	63	4.08	0.00001*
MH vs. L	63	1.37	0.1750	62	2.02	0.0474*
CL vs ML	62	3.36	0.0014*	62	3.45	0.0010*

Table 2. Age 1 vs. age 2 *t*-test results, including gonial angle (GA), mandible height-to-mandible length ratio (MH vs. L), and cranial length-to-mandible length ratio (CL vs. ML). Significant results are indicated with an asterisk.

	Male			Female		
	df	*t*	*p*-value	*df*	*t*	*p*-value
GA	70	3.25	0.0018*	56	0.63	0.5281
MH vs. L	69	13.17	0.0001*	56	7.60	0.0001*
CL vs ML	68	15.95	0.0001*	56	15.10	0.0001*

Table 3. Impacted vs. non-impacted *t*-test results, including gonial angle (GA), mandible height-to-mandible length ratio (MH vs. L), and cranial length-to-mandible length ratio (CL vs. ML). No significant results were found.

	Male			Female		
	df	*t*	*p*-value	*df*	*t*	*p*-value
GA	34	0.54	0.5925	56	0.32	0.7520
MH vs. L	33	0.52	0.6100	27	0.10	0.9211
CL vs ML	33	0.71	0.7069	27	0.69	0.4940

The GA, cranial length, and mandibular length were measured for each radiograph (Fig. 3). Mandibular height-to-length and cranial length-to-mandible length ratios were then calculated, and t-tests were conducted to assess variation in GA, mandible-to-length ratio, and cranial length-to-mandible length ratio between groups. The assessed groups included 1) male vs. female, 2) age 1 vs. age 2, and 3) impacted vs. non-impacted mandibular third molar (at age 2). The values recorded for each t-test included degrees of freedom, t-value, and p-value, which had to be greater than 0.05 to be considered statistically significant.

RESULTS

The only measurement found to be sexually dimorphic at age 1 was the cranial length-to-mandibular length ratio. Significant sexual dimorphism was found for all sampled measurements at age 2 (Table 1).

When comparing age 1 vs. age 2, males showed significant developmental variation for all assessed measurements. Females, however, did not show significant change in GA between the two sampled age groups (Table 2).

When comparing individuals with an impacted mandibular third molar vs. those without impaction (Fig. 4), no significant difference was found in GA or mandibular height-to-length ratio for males or females (Table 3).

DISCUSSION

Sexual dimorphism is known to increase during puberty due to variations in sex and growth hormones and other factors (Ursi et al., 1993; Kleisner et al., 2021). This pattern is supported here, with GA and mandible height-to-length ratio becoming sexually dimorphic between age 1 (7.0 to 9.3 years) and age 2 (15.9 to 21.0 years).

The cranial length-to-mandible length ratio shows significant sexual dimorphism at both age groups, possibly illustrating the role of allometry in craniofacial development (Kleisner et al., 2021). Sexual selection could be a possible cofactor influencing facial and mandibular morphology, with selection for slender mandibular morphology in females and larger, more robust mandibular morphology in males (Kleisner et al., 2021).

We found that the GA changes significantly in males between ages 1 and 2, while it does not change over time in females. It is possible that hormonal differences during and after puberty may factor in bone remodeling. Sex steroid hormones have been shown to be a factor in musculoskeletal development during puberty (Plotkin et al., 2024). Both sexes have a constant bone mineral content (BMC) growth rate, but once puberty begins, the growth paths between males and females become increasingly distant. Plotkin and colleagues (2024) discuss that boys have approximately one more year of growth after the onset of puberty compared to girls, and that girls mature about two years earlier than boys due to the BMC growth rate discrepancy. This pattern of growth leaves more time for mandibular differences to develop between males and females.

Differences in muscle mass may also play a role in the sexual dimorphism of mandibular development during and after puberty. Increased testosterone levels in males have been linked to increased mass and strength of the mastication muscles; specifically, the masseter, pterygoid, and temporalis muscles (Plotkin et al., 2024). With males theoretically applying increased forces on the mandible from the masticatory muscles, this could further influence bone remodeling, contributing to differences in GA development (Plotkin et al., 2024).

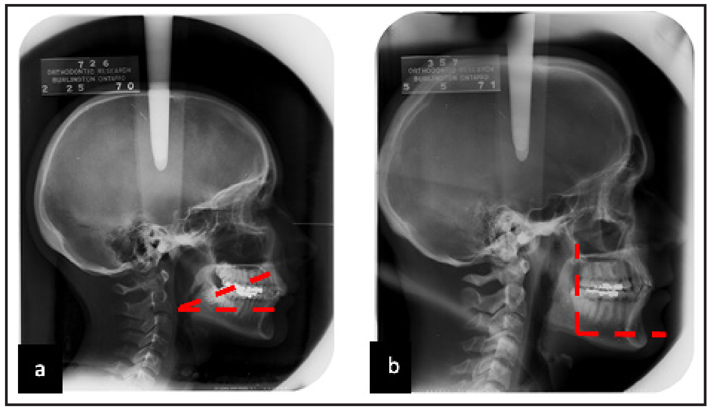

Figure 4. a) Impacted third molar, b) non-impacted third molar. Red lines show the angle of mandibular third molar eruption.

Surprisingly, we did not find a significant correlation between mandibular third molar impaction and any of the sampled mandibular measurements. These results contradict a previous study by Barone and colleagues (2021), which found a lower GA and smaller retromolar space to be associated with an increase in mandibular third molar impaction. However, our results support the study conducted by Özkubat and colleagues (2024), which found that third molar impaction was not linked to GA. These authors instead argue that other measurements, including the angle between the gonion-symphysis plane and the long axis of the third molars (A°) and the retromolar eruption distance (RED) could be more reliable predictors of the third molars (Fig. 5).

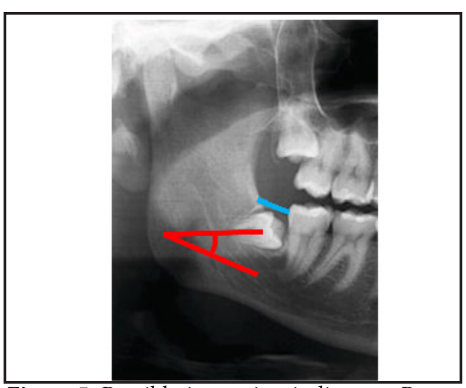

Figure 5. Possible impaction indicators. Retromolar eruption distance (blue). A° (red).

CONCLUSION

Our study assesses the role of sexual dimorphism in the development and impaction of mandibular third molars. We argue that variations in craniofacial growth patterns between males and females, influenced by hormonal changes during puberty, contribute to differences in mandibular dimensions and GA. These differences are crucial in understanding the prevalence and risk factors associated with third molar impaction. Our findings suggest that while GA and mandibular height-to-length ratio exhibit sexual dimorphism, other developmental factors may play a more significant role in mandibular third molar impaction.

The present study highlights the importance of considering alternate measurements, such as the angle between the gonion-symphysis plane and the long axis of the third molars (A°) and the retromolar eruption distance (RED), in predicting impaction risk. These findings have practical clinical implications, emphasizing the need for comprehensive evaluations to predict and manage mandibular third molar impactions effectively.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the American Association of Orthodontists Foundation (AAOF), for the distribution of cephalograms. This study was made possible by use of material from the Burlington Growth Centre, Faculty of Dentistry, University of Toronto, which was supported by funds provided by Grant (1) (No.

605-7-299) National Health Grant (Canada), (data collection); (2) Province of Ontario Grant PR 33 (duplicating) and (3) the Varsity Fund (for housing and collection).

LITERATURE CITED

Abuhijleh, E., Warreth, A., Qawadi, M., Abdulrida, E., Radaideh, A., Al Taki, A., Mathew, A., Varma S. 2019. Mandibular Gonial Angle Measurement as a Predictor of Gender – A Digital Panoramic Study. The Open Dentistry Journal 13: 399-404.

Barone, S., Antonelli, A., Averta, F., Diodati, F., Muraca, D., Bennardo, F., Giudice, A. 2021. Does Mandibular Gonial Angle Influence the Eruption Pattern of the Lower Third Molar? A Three-Dimensional Study. JCM 10(18): 40-57.

Biswari, G., Gupta, P., Das, D. 1970. Wisdom Teeth - A Major Problem in Young Generation, Study on the Basis of Types and Associated Complications. J Coll Med Sci-Nepal 6(3): 24–28.

Hasan., L.S., Ahmad, F.T., Abdullah, E.H. 2016. Impacted Wisdom Teeth, Prevalence, Pattern of Impaction, Complications and Indication for Extraction: A Pilot Clinic Study in Iraqi Population. TJDS 4(1): 50–62.

Kleisner, K., Tureček, P., Roberts, S.C., Havlíček, J., Valentova, J.V., Akoko, R.M., Leongómez, J.D., Apostol, S., Varella, M.A.C., Saribay, S.A. 2021. How and Why Patterns of Sexual Dimorphism in Human Faces Vary across the World. Sci Rep 11(1): 59-78.

Özkubat, Y.A., Saruhan Köse, N., Koşar, Y.Ç., TekiN, G., Dereci, Ö. 2024. Investigation of the Relationship Between Mandibular Gonial Angle and Impacted Mandibular Third Molar. Neu Dent J 6(2): 192-199.

Plotkin, L.I., Bruzzaniti, A., Pianeta, R. 2024. Sexual Dimorphism in the Musculoskeletal System: Sex Hormones and Beyond. Journal of the Endocrine Society 8(10): bvae153.

Ursi, W.J., Trotman, C.A, McNamara Jr., J.A., Behrents, R.G. 1993. Sexual dimorphism in normal craniofacial growth. The Angle Orthodontist. 63(1): 47-56.

Yu, X., Yu, H., Wang, C., Wu, T., Liu, W., Qu, Z., Chang, L., Ren, F. 2022. The Influence of the Eruption of Mandibular Third Molars on the Craniofacial Morphology in Han Youth of North China. Life Res 5(2): 9.