# Presence and Maturation Dynamics of Mandibular Third Molars and Their Influence on Late Mandibular Incisor Crowding: Longitudinal Study

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**Research Article**

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# Abstract

OBJECTIVE: To investigate the relationship between the presence and dynamics of mandibular third molar development and the occurrence and amount of late mandibular incisor crowding.

MATERIALS AND METHODS: Dental plaster casts and panoramic radiographs of 72 orthodontically untreated subjects from the Nittedal growth study, Norway were analysed. The subjects were recalled for check-up at 12, 15, 18 and 21 years of age. Mandibular incisor crowding was assessed using the Little's irregularity index and dental maturation of the third molars by the Cameriere's index.

RESULTS: The majority of the subjects (64%) had ≥1mm increase in irregularity; 22% experienced increase of 0.1-0.9mm and 14% had unchanged or decreased irregularity. Incisor irregularity increased with age, regardless of absence or presence of third molars. The amount of change in incisor irregularity from 12 to 21 years did not differ significantly between subjects with hypodontia of third molars, extraction and those with third molars present. No differences were observed between erupted, unerupted or impacted third molars. No correlation was found between the amount of change in irregularity and maturation of the third molars.

CONCLUSIONS: Occurrence and amount of mandibular late incisor crowding is not significantly influenced by presence or development dynamics of mandibular third molars.

# Introduction

The relationship between third molars and mandibular incisor crowding is one of the most debated and studied fields in orthodontics, and despite all, is still quite controversial. Late crowding is considered to have multifactorial etiology, whereas etiological factors may differ between individuals. Proposed etiological factors include differential growth of the jaws, functional and parafunctional pressure of the soft tissues, muscular imbalance and distribution of the anterior component of the occlusal force [1, 2]. Many studies have attempted to clarify and evaluate the third molars and incisor crowding interrelationship [3–8]. Mandibular incisor crowding is highly prevalent, as up to 40% of the general population has moderate to severe crowding [9]. Given the esthetic demands, maxillary incisor crowding is one of the most frequent reasons for seeking orthodontic treatment [10]. However, with aging, there is a gradual decrease of exposure of upper incisor, accompanied by an increase in lower incisor exposure [11], making the lower crowding more visible therefore compromising smile esthetics.

Skeletal maturation can be influenced by environmental and hereditary factors. On the other hand, teeth are much more reliable for age estimation because its tissues do not undergo continuous remodeling processes. During time, versatile dental age estimation methods have been developed. In 2006, Cameriere [12] presented a method based on a measurement of open apices of the teeth. The method was originally applied on Italians and then applied on different European and non-European subjects [13–16]. It was reported as very accurate, because it showed that variability between samples did not significantly influence the regression formula [17]. When applied to third molars, this method showed very high percentage of correctly classified cases in European subjects [18].

Crowding as an occlusal trait becomes more common during dentition development and aging, due to maturational, regressive and degenerative factors [1, 2, 19]. Incisor crowding most commonly manifests as tooth rotations and labiolingual displacement from the arch line, often followed by different amounts of mesiodistal overleap of contact points [20]. Late crowding is observed in mandibular incisors during late adolescence and it is considered to be a late expression of primary crowding [1, 19].

Increase in mandibular incisor crowding was reported to occur between 13 and 26 years, in the late adolescence and early adulthood [21, 22]. It often coincides with the eruption of mandibular third molars, which might imply their causal role. However, it seems that the role of mandibular third molars in anterior crowding cannot be categorically denied [23].

Late mandibular incisor crowding is observed in both treated and untreated subjects, and worsens with age, most evidently due to decrease in arch length and perimeter and mandibular dental arch becoming more square-shaped [21, 24–26].

Many literature reviews [27–29] attempted to affirm the relationship between third molars and crowding, however due to questionable methods, lack of standardization, various inclusion criteria and study designs definite conclusion on this interrelationship cannot be set [29]. Some authors attributed the incisor crowding to the mesial pressure exerted by the mandibular third molar [4], on the other hand others do not consider this pressure capable of causing anterior crowding [3]. Some research findings report that no strong relation exists between the third molar eruption level, space, and angulations to mandibular anterior crowding [6]. It seems that the only connection between crowding and eruption of the third molars is the concurrent occurrence of the two phenomena [30].

The aim of this study was to investigate presence and mandibular third molar development dynamics, i.e., rate; occurrence and amount of late mandibular incisor crowding and their possible interrelationship.

Hypotheses were that decelerated development and absence of eruption of mandibular third molars could influence the amount of mandibular incisor crowding.

## Subjects And Methods

The sample of the study was part of the Nittedal growth study, collected by the Department of Orthodontics, University of Oslo, Norway. It includes documentation of 4229 orthodontically untreated subjects, residents of Nittedal County in Norway born between 1958 and 1972. Subjects had no significant malocclusions nor facial disharmonies at the start of follow-up at six years of age and received no orthodontic treatment. They were followed up every three years from the age of 6 to 21 years. However, the number of subjects with complete documentation for period of 12 years was limited since those that had orthodontic treatment were excluded from the sample.

Inclusion criteria was presence of panoramic radiographs and plaster casts at the ages of 12, 15, 18 and 21. After selection of the cases with required documentation, the sample consisted of 72 subjects (47% female) longitudinally followed from 12 to 21 years, every 3 years.

Maturation stage of the left mandibular third molar was determined on panoramic radiographs at the age of 15, 18 and 21 using the Cameriere's method [12]. Maturation stage was not evaluated at the age of 12 since mandibular third molars were insufficiently developed for this analysis. Distances between inner walls of open root apices of mesial (A1) and distal (A2) roots were measured and added up and then divided by measured tooth length (B) [12] (Fig. 1). Congruence of maturation of left and right mandibular third molar was evaluated in 30 subjects at every age.

Late incisor crowding was measured on plaster casts using Little's irregularity index (the irregularity index) [20] which quantifies the aberration of contact points of mandibular incisors as a sum of displacement of contact points of neighboring teeth from canine to canine.

Subjects' plaster casts were photographed on a surface containing a gauge, from a normed distance of 0.6 m, in order to calibrate and facilitate their analysis in software AudaxCeph (Audax, Ljubljana, Slovenia) (Fig. 2). One researcher (M.Z.) measured irregularity index and the other one (L.M.) measured the rate of third molar maturation in order to control observer bias.

# Ethical Considerations

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 2013 revision of Helsinki declaration. The University of Rijeka Ethics Committee approved the study (No. 2170-24-01-15-2).

Since the Nittedal growth material data was collected in 1970s, written informed consent was not mandatory. The collected data were later anonymized and according the regulations, there is no need for further ethical approval. The project was approved by NAVF (Norwegian research Council) / C.50.73-1.

# Statistical analysis

Statistical analyses included a t-test, Pearson and intraclass correlations, linear and logistic regression. All statistical analyzes were made in commercial software IBM SPSS 22 (IBM Corp, Armonk, USA).

## Results

Descriptive statistics of the sample is presented in Table 1.

The change in mandibular incisor irregularity from 12 to 21 years of age was in range −2.8-6.3 mm (mean 1.6±1.7). The majority of the subjects (64%) had ≥1mm increase in irregularity, 22% experienced increase of 0.1-0.9mm and 14% had unchanged or decreased irregularity. Increase was more frequent between 12-15 years (in 86.2% of cases). Additional crowding was observed between 15 and 18 years in 84.6% and between 18 and 21 years of age in 86.6% of cases. Hypodontia of mandibular third molars was present in 11% of the subjects (in half unilateral), while 22% had their third molars removed at the age of 18 (57% unilateral). Among the subjects with present mandibular third molars at the age of 21, 45% had erupted (33% bilateral, 11% unilateral), 22% unerupted (8% bilateral and 14% unilateral), 33% impacted (27% bilateral and 6% unilateral). Incisor irregularity increased with age, regardless of absence or presence of third molars (Figure 3). The amount of change in incisor irregularity from 12 to 21 years and incidence of additional irregularity did not differ significantly between subjects with hypodontia of third molars, extraction and those with third molars present (Figure 4, Table 2). Both incidence and increase of irregularity were the lowest in cases with hypodontia. Neither incidence nor increase of incisor irregularity differed significantly between the subjects with erupted, unerupted and impacted mandibular third molars (Figure 5, Table 2). The results were similar when analyzed separately for unilateral or bilateral extractions, hypodontia, eruption and/or impaction Therefore, the results are pooled (Figure 3, 4 and 5, Table 2). Hypodontia of at least one mandibular third molar was taken as a dominant condition, followed by extraction of at least one mandibular third molar. If erupted, impaction was taken as dominant condition, followed by non-eruption of at least one mandibular third molar. The changes in irregularity were similar from 18 to 21 years in those that extracted and retained their third molars (0.6±0.6 vs. 0.4±0.9). The incidence of additional crowding after the age of 18 was similar in extraction and non-extraction cases (48 vs 40%). Differences in the amount of changes between males and females were not statistically significant.

Agreement in maturation of left and right mandibular third molars was good to excellent, ranging from 0.863-0.963 and it was lowest at the age of 15. The rate of the third molar apex closure in the whole sample was bigger from the age of 15 to 18, than from the age of 18 to 21 with large effect size ($p<0.001$, $r=0.885$, Table 1). Maturation of the third molar from the age of 18 to 21 was more pronounced in females than males with large effect size (0.31±0.17 vs 0.16±0.10, $p<0.001$, r=0,503), while somewhat higher in males between 15-18 years in comparison to females (0.68±0.22 vs. 0.62±0.24).

The amount of change of lower incisor irregularity between the age of 12 and 21 was not linearly correlated with the rate of third molar apex maturation at any age range (15-18 years, 18-21 years nor 15-21 years). When the influence of sex was controlled for in the linear regression, likewise, there was no correlation between the amount of change of lower incisors and maturation of third molars. Presence of mandibular third molars, their developmental rate and sex were not significant predictors of occurrence of mandibular incisor irregularity in logistic regression models.

# Discussion

The present study confirmed that mandibular third molars are not related to late incisor crowding in the mandible. The hypotheses that decelerated development and absence of eruption of third molars could influence the amount of incisor crowding are rejected.

Hypodontia of third molars in the mandibule did not reduce the odds for late incisor crowding and subjects with hypodontia had similar amounts of incisor crowding as those with third molars present. Our findings support previous studies which showed that neither presence nor absence of mandibular third molars influences lower incisor crowding [24, 31].

This study has shown that extraction of third molars at the age of 18 did not reduce the amount of change in irregularity of mandibular incisor or odds for its occurrence in the next three years similar as it has been previously reported [3]. Unilateral extraction of mandibular third molars may slightly reduce crowding on the extraction side [4], but with questionable clinical relevance (− 0.4 to + 0.8 mm), hence extraction is not justified [3]. The present study confirmed that impaction od mandibular molars is not related to incisor crowding which agrees with previous findings, including analysed depth and angulation [5].

One study identified relationship between mandibular crowding and the angulation of mandibular third molars, suggesting that calculation of the Ganss ratio could serve as indication for removal of third molars [7]. However, this study was recently discredited due to restricted sample size [8].

It is evident from the present research that people without third molars also exhibit an increase in incisor irregularity with age, although in a slightly smaller amount and somewhat less frequently. However, there is a large interindividual variability and given the small number of people with hypodontia in the sample and lack of statistical significance, it cannot be argued that there is a relationship. It is questionable whether it would be justified to perform a germectomy of the third molars at an early age just to slow down the occurrence of crowding.

Even though some studies suggest that crowding differs between the erupted and extracted or absent third molars group [32], according to our study, it seems that neither impaction nor eruption of third molars influences the amount of crowding. Crowding is also similar regardless of unilateral or bilateral extraction, hypodontia, eruption, and/or impaction of third molars. Also, due to ethical considerations, all the studies of the untreated subjects are based on historical samples which have not experienced secular growth trends over the past century, hence making their conclusions of questionable quality. Studies include opposing reports of whether secular trends influence dental maturity or not [33, 34]. Some research implies that a positive secular trend in dental maturity, i.e. faster dental development is observed [34]. Turkish researchers report that more rapid dental maturation is observed in girls in comparison with boys of the same age, even though no significant generational secular trends were observed [33].

According to the present study, maturation rate of third molars does not influence late crowding of mandibular incisors. To our knowledge, there were no studies investigating relationship between third molar maturation and dental crowding. However, one study investigated the synchronism of dental maturation and facial development and its impact on crowding. They concluded that asynchronous dentofacial development could partially explain the frequency of dental crowding in modern populations [35]. It also seems that a secular trend is observed in the development of third molars: the onset begins earlier, and then decelerates [36]. Calcification and eruption of third molars is reported to be affected by ethnicity [37]. It could be that secular trends in development of the dentofacial complex, transition to an agricultural lifestyle and reduced masticatory function [38, 39] are behind earlier third molar maturation and incisor crowding.

The strength of this study is the longitudinal research design that followed occurrence and amount of the mandibular incisor crowding during time, as well as the rate of maturation and position of the mandibular third molars. Therefore, several biases were controlled, namely selection bias and temporal bias, in comparison to retrospective and cross-sectional study designs. Since one investigator measured the irregularity index and the other one measured the rate of third molar maturation, observer bias was also controlled. Another strength of this study is the multivariable regression analysis which controlled for more than one confounder at the same time and allowed interpretation of each confounder individually.

# Conclusion

Occurrence and amount of mandibular late incisor crowding is not significantly influenced by the presence of mandibular third molars or their development dynamics.

# Declarations

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### Author contributions

M.Z. – analysis, statistical analysis, data interpretation, writing the original draft, funding acquisition

A.P. – sample selection, analysis design, analysis, writing – review & editing

L.M. – analysis design, analysis, methodology, writing – review & editing

V.V.R. – data collection, methodology, supervision, writing – review & editing

S.S. – sample selection, methodology, study design, supervision, writing – review & editing, funding acquisition

All authors reviewed and approved final version of this manuscript.

### Disclosure of potential conflict of interest

Authors declare no conflict of interest.

# References


1. Richardson, M.E. Late lower arch crowding in relation to skeletal and dental morphology and growth changes. *Br J Orthod*. **23**, 249-254 (1996).
2. Ihlow, D., Kubein-Meesenburg, D., Fanghänel, J., Lohrmann, B., Elsner, V. & Nägerl, H. Biomechanics of the dental arch and incisal crowding. *J Orofac Orthop*. **65**, 5-12 (2004).
3. Harradine, N.W.T., Pearson, M.H. & Toth, B. The effect of extraction of third molars on late lower incisor crowding: a randomized controlled *Br J Orthod*. **25**, 117-122 (1998).
4. Lindqvist, B. & Thilander, B. Extraction of third molars in cases of anticipated crowding in the lower jaw. *Am J Orthod*. **81**, 130-139 (1982).
5. Okşayan, R. & Topcuoglu, T. Effects of Mandibular Third Molar Angulation and Position on Crowding. *Turkish Journal of Orthodontics*. **26**, 129-133 (2013).
6. Sood, A., Bhullar, M., Mittal, S., Aggarwal, I., Singla, D. & Sharma, A. Relationship of mandibular third molar to mandibular anterior crowding. *Dent J Adv Stud*. **6**, 89–96 (2018).
7. Niedzielska I. Third molar influence on dental arch crowding. *Eur J Orthod*. **27**, 518-523 (2005).
8. Hasegawa, Y., Terada, K., Kageyama, I., Tsuchimochi, T., Ishikawa, F. & Nakahara, S. Influence of third molar space on angulation and dental arch crowding. *Odontology*. **101**, 22–28 (2013).
9. Buschang, P.H., Stroud, J. & Alexander, R.G. Differences in dental arch morphology among adult females with untreated Class I and Class II malocclusion. *Eur J Orthod*. **16**, 47–52 (1994).
10. Marques, L.S., et al. Factors associated with the desire for orthodontic treatment among Brazilian adolescents and their parents. *BMC Oral Health*. **9**, 34 (2009).
11. Dong, J.K., Jin, T.H., Cho, H.W. & Oh, S.C. The esthetics of the smile: a review of some recent studies. *Int J Prosthodont*. **12**, 9-19 (1999).
12. Cameriere, R., Ferrante, L. & Cingolani, M. Age estimation in children by measurement of open apices in teeth. *Int J Legal Med*. **120**, 49-52 (2006).
13. Galic, I., et al. Accuracy of Cameriere, Haavikko, and Willems radiographic methods on age estimation on Bosnian-Herzegovian children age groups 6-13. *Int J Legal Med*. **125**, 315-321 (2011).
14. Mazzilli, L.E.N., Melani, R.F.H., Lascala, C.A., Palacio, L.A.V. & Cameriere, R. Age estimation: Cameriere's open apices methodology accuracy on a southeast Brazilian sample. *J Forensic Leg Med.* **58**, 164-168 (2018).
15. Marinkovic, N., Milovanovic, P., Djuric, M., Nedeljkovic, N. & Zelic, K. Dental maturity assessment in Serbian population: A comparison of Cameriere's European formula and Willems' method. *Forensic Sci Int*. **288**, 331.e1-331.e5 (2018).
16. Gannepalli, A., Balla, S.B., Pacha, V.B., Gandhi Babu, D.B., Vinay, B.H. & Perkari, S. Applicability of Cameriere European formula for age estimation of 10-15 years legal threshold in South Indian population. *J Forensic Dent Sci*. **11**, 78-83 (2019).

17. Cameriere, R., De Angelis, D., Ferrante, L., Scarpino, F. & Cingolani, M. Age estimation in children by measurement of open apices in teeth: a European formula. *Int J Legal Med*. **121**, 449-453 (2007).
18. De Luca, S. et al. Accuracy of Cameriere's cut-off value for third molar in assessing 18 years of age. *Forensic Sci Int*. **235**, 102e1-102e6 (2014).
19. Legović, M., Cehić, A. Longitudinal analysis of the development of eugnathia and dysgnathia from the primary dentition to the permanent dentition. *Acta Stomatol Croat*. **20**, 3-9 (1986).
20. Little, R.M. The irregularity index: a quantitative score of mandibular anterior alignment. *Am J Orthod*. **68**, 554-563 (1975).
21. Bishara, S.E., Jakobsen, J.R., Treder, J.E., Stasl, M.J. Changes in the maxillary and mandibular tooth size-arch length relationship from early adolescence to early adulthood: a longitudinal study. *Am J Orthod Dentofacial Orthop*. **95**, 46–59 (1989).
22. Zigante, M., Pavlic, A., Vandevska Radunovic, V., Mathewson, A., Kotarac Knezevic, A. & Spalj, S. Changes of mandibular dental arch shape during adolescence and its influence on late mandibular incisor crowding. *Homo*. **70**, 185-192 (2019).
23. Richardson ME. Late lower arch crowding in relation to primary crowding. Angle Orthod. **52**, 300–312 (1982).
24. Ades, A.G., Joondeph, D.R., Little, R.M. & Chapko, M.K. A long-term study of the relationship of third molars to changes in the mandibular dental arch. *Am J Orthod Dentofacial Orthop*. **97**, 323-335 (1990).
25. Vego, L. A longitudinal study of mandibular arch perimeter. *Angle Orthod*. **32**, 187–192 (1962).
26. Little, R.M., Wallen, T.R., Riedel, R.A. Stability and relapse of mandibular anterior alignment-first premolar extraction cases treated by traditional edgewise orthodontics. *Am J Orthod*. **80**, 349–365 (1981).
27. Zawawi, K.H. & Melis, M. The role of mandibular third molars on lower anterior teeth crowding and relapse after orthodontic treatment: a systematic review. *Scientific World Journal*. **2014**, 615429 (2014).
28. Stanaitytė, R., Trakinienė, G. & Gervickas, A. Do wisdom teeth induce lower anterior teeth crowding? A systematic literature review. *Stomatologija*. **16**, 15-18 (2014).
29. Genest-Beucher, S., Graillon, N., Bruneau, S., Benzaquen, M. & Guyot, L. Does mandibular third molar have an impact on dental mandibular anterior crowding? A literature review. *J Stomatol Oral Maxillofac Surg*. **119**, 204-207 (2018).
30. Solow, B., Siersbaek-Nielsen, S. & Greve E. Airway adequacy, head posture, and craniofacial morphology. *Am J Orthod*. **86**, 214–223 (1984).
31. Karasawa, L.H., Rossi, A.C., Groppo, F.C., Prado, F.B. & Caria, P.H.F. Cross-sectional study of correlation between mandibular incisor crowding and third molars in young Brazilians. *Med Oral Patol Oral Cir Bucal*. **18**, 505-509 (2013).

32. Cheng, H.C., Peng, B.Y., Hsieh, H.Y. & Tam, K.W. Impact of third molars on mandibular relapse in post-orthodontic patients: A meta-analysis. *J Dent Sci*. **13**, 1-7 (2018).
33. Kaygisiz, E., Uzuner, F.D., Yeniay, A. & Darendeliler, N. Secular trend in the maturation of permanent teeth in a sample of Turkish children over the past 30 years. *Forensic Sci Int*. **259**, 155-160 (2016).
34. Sasso, A., Spalj, S., Mady Maricic, B., Sasso, A., Cabov, T. & Legović, M. Secular trend in the development of permanent teeth in a population of Istria and the littoral region of Croatia. *J Forensic Sci*. **58**, 673-677 (2013).
35. Yan-Vergnes, W., Vergnes, J.N., Dumonce, l.J., Baron, P., Marchal-Sixou, C. & Braga, J. Asynchronous dentofacial development and dental crowding: a cross-sectional study in a contemporary sample of children in France. *J Physiol Anthropol*. **32**, 22 (2013).
36. Sasso, A., Legovic, M., Mady Maricic, B., Pavlic, A. & Spalj, S. Secular trend of earlier onset and decelerated development of third molars: evidence from Croatia. *Forensic Sci Int*. **249**, 202-206 (2015).
37. Meinl, A., Tangl, S., Huber, C., Maurerd, B. & Watzekc, G. The chronology of third molar mineralization in the Austrian population–a contribution to forensic age estimation. *Forensic Sci Int*. **169**, 161-167 (2007).
38. von Cramon-Taubadel, N. Global human mandibular variation reflects differences in agricultural and hunter-gatherer subsistence strategies. *Proc Natl Acad Sci USA*. **108**, 19546–19551 (2011).
39. Normando, D., Almeida, M.A.O. & Quintão, C.C.A. Dental crowding. *Angle Orthod*. **83**, 10–15 (2013).

# Tables

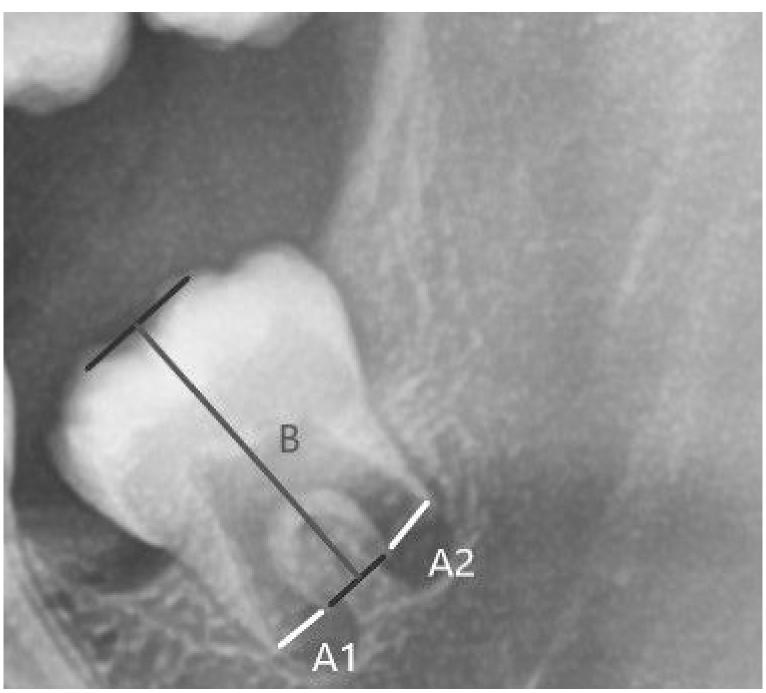
Table 1. Descriptive statistics of the sample

| Variable | Mean±SD | Median (IQR) | Range (min-max) |
|---|---|---|---|
| Irregularity index 12y (mm) | 2.4±1.3 | 2.2 (1.4-3.2) | 0.4-5.7 |
| Irregularity index 21y (mm) | 3.9±2.0 | 3.8 (2.3-4.7) | 0.9-10.4 |
| Change of irregularity index 21-12y (mm) | 1.6±1.7 | 1.4 (0.5-2.5) | -2.8-6.3 |
| Cameriere index 15y | 0.95±0.37 | 0.89 (0.77-1.10) | 0.28-2.27 |
| Cameriere index 18y | 0.28±0.24 | 0.20 (0.10-0.39) | 0.01-0.97 |
| Cameriere index 21y | 0.05±0.11 | 0.01 (0.01-0.02) | 0.00-0.58 |
| Change of Cameriere index 18-15y | 0.68±0.23 | 0.67 (0.50-0.82) | 0.24-1.36 |
| Change of Cameriere index 21-18y | 0.23±0.15 | 0.20 (0.11-0.34) | 0.01-0.68 |
| Change of Cameriere index 21-15y | 0.90±0.31 | 0.87 (0.74-1.06) | 0.26-2.00 |

Table 2. Comparison of the change of the Little's irregularity index in the period 12-21 years between the groups with present, hypodontia and extracted third molars

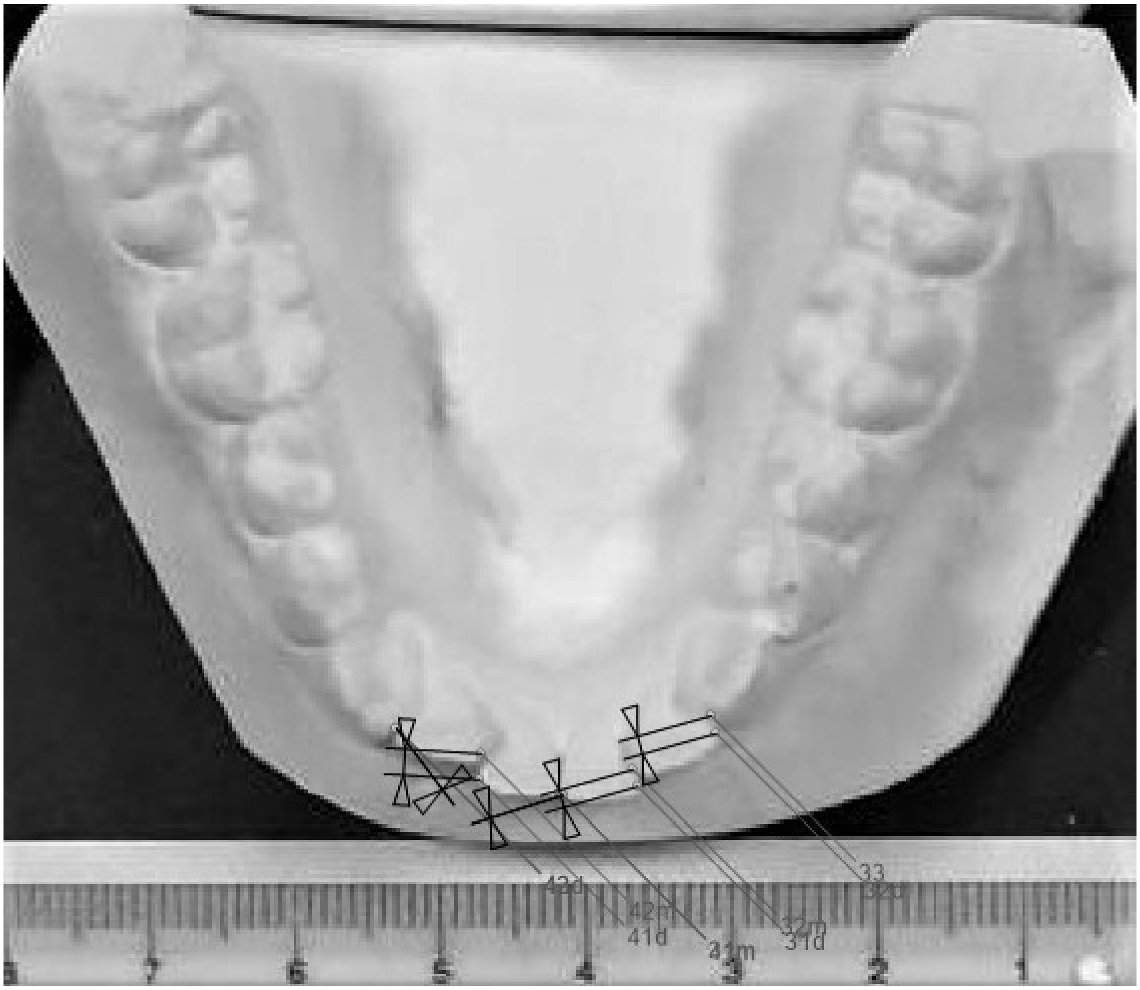
| Group | Incidence of additional irregularity (≥1mm) | Incidence of additional irregularity (≥2mm) | Mean±SD | Median (IQR) | Range (min-max) |
|---|---|---|---|---|---|
| Third molars present at 21 y | 65% | 38% | 1.8±1.6 | 1.4 (0.6-2.7) | -0.8-6.1 |
| Hypodontia of third molars | 38% | 25% | 0.5±1.8 | 0.4 (-0.6-2.2) | -2.8-2.5 |
| Extraction of the third molars at 18 y | 75% | 19% | 1.7±2.0 | 1.3 (0.6-1.9) | -0.9-6.3 |
| Impacted at 21 y | 53% | 29% | 1.3±1.4 | 1.2 (0.3-2.5) | -0.7-4.7 |
| Unerupted at 21 y | 82% | 27% | 1.9±1.5 | 1.7 (1.3-2.2) | 0.3-6.1 |
| Erupted at 21 y | 65% | 39% | 1.7±1.6 | 1.4 (0.7-2.8) | -0.9-5.4 |

# Figures



## Figure 1

Cameriere's index measurement




## Figure 2

Little's irregularity index measurement in AudaxCeph software

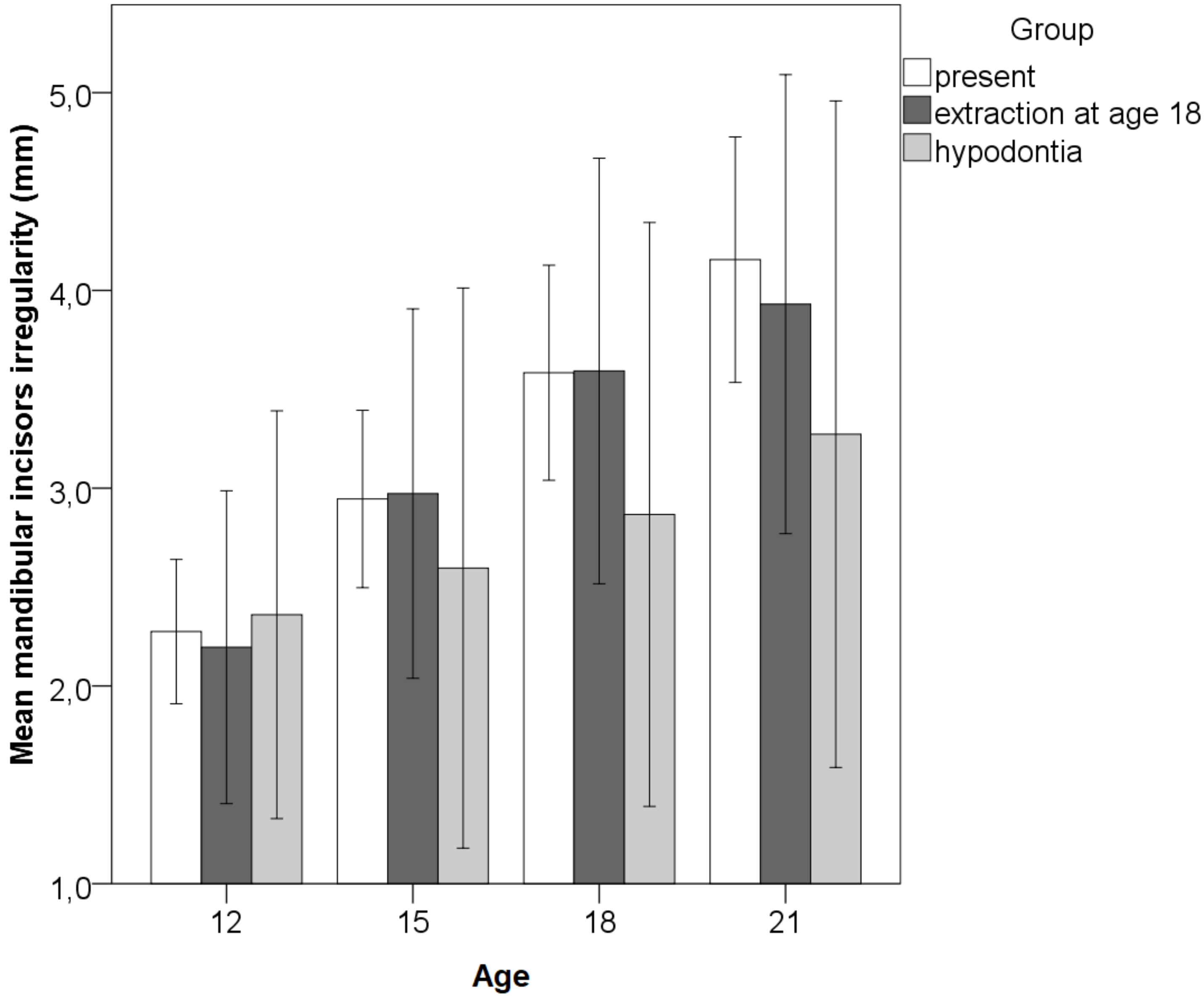



**Figure 3**

Comparison of mandibular incisor irregularity (The irregularity index) from the age of 12 to 21 years between the groups with present, hypodontia or extracted third molars (whiskers present 95% confidence intervals)

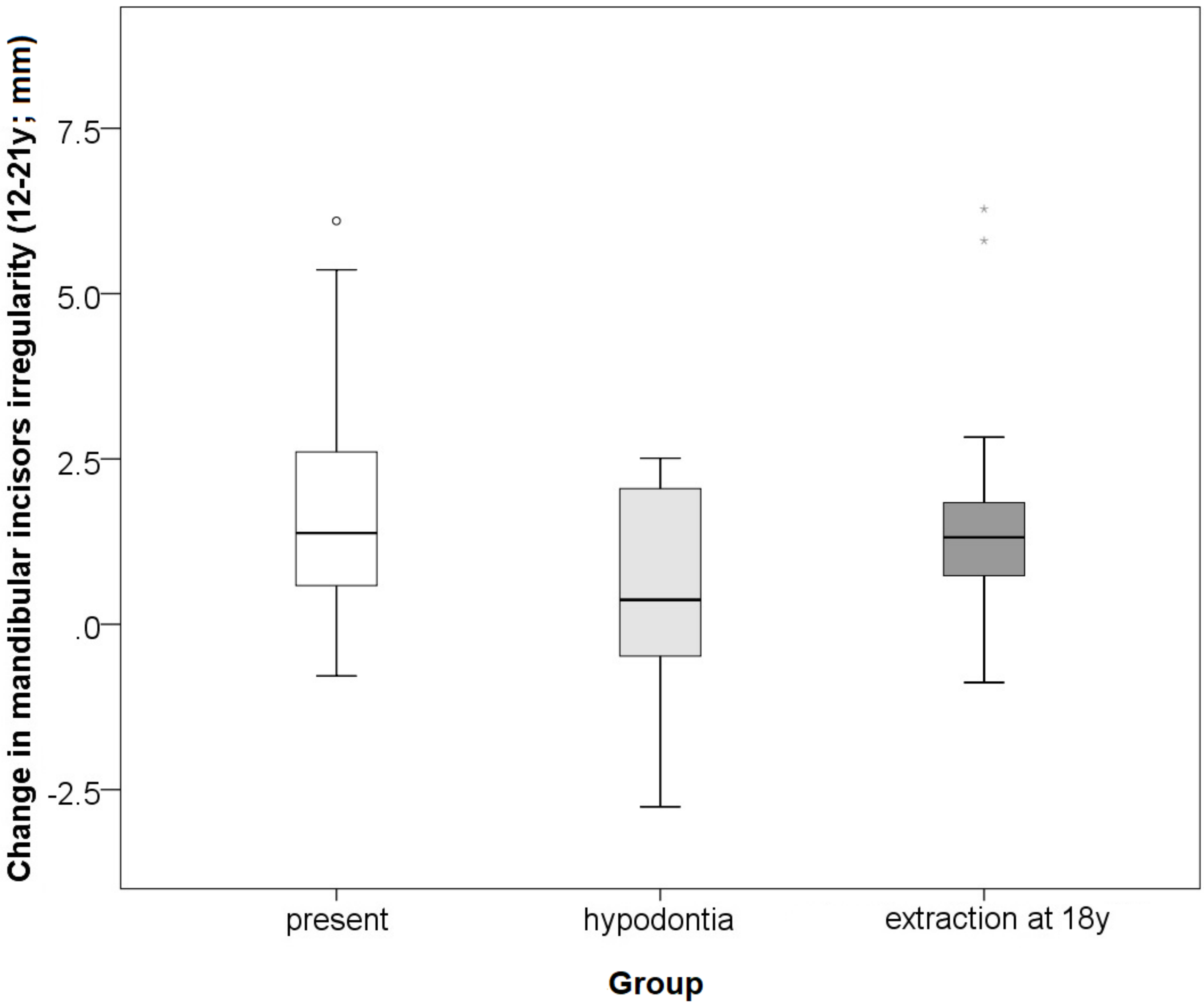
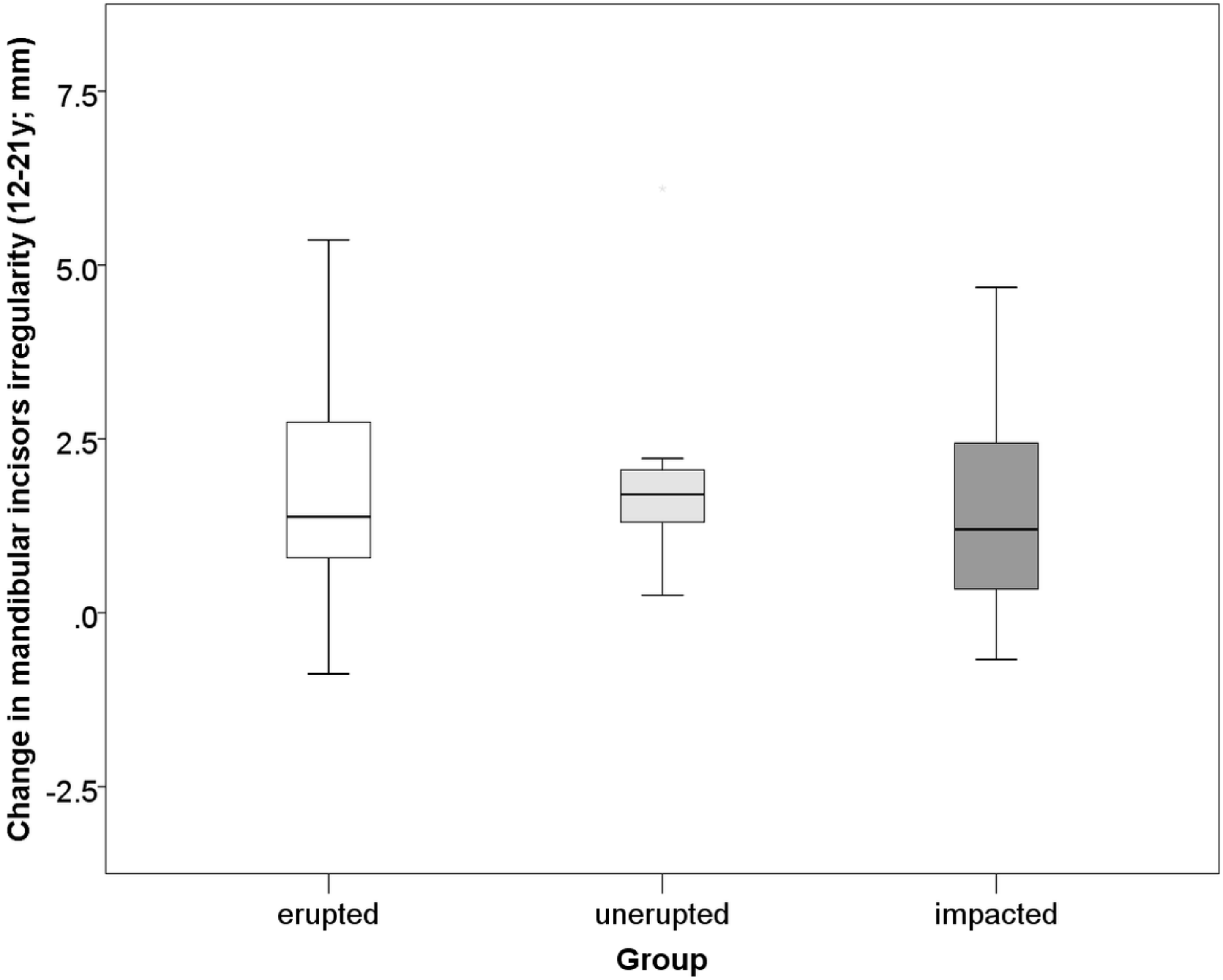



**Figure 4**

Comparison of change in mandibular incisor irregularity (The irregularity index) from 12 to 21 years between the groups with present, absent and extracted third molars




## Figure 5

Comparison of change in mandibular incisor irregularity (The irregularity index) from 12 to 21 years between the groups with erupted, unerupted and impacted third molars