Original Article

Radiographic assessment of lower third molar eruption in different anteroposterior skeletal patterns and age-related groups

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ABSTRACT

Objective: To analyze radiographic predictors for lower third molar eruption among subjects with different anteroposterior skeletal relations and of different age groups.

Materials and Methods: In total, 300 lower third molars were recorded on diagnostic digital orthopantomograms (DPTs) and lateral cephalograms (LCs). The radiographs were grouped according to sagittal intermaxillary angle (ANB), subject age, and level of lower third molar eruption. The DPT was used to analyze retromolar space, mesiodistal crown width, space/width ratio, third and second molar angulation (α, γ), third molar inclination (β), and gonion angle. The LC was used to determine ANB, angles of maxillar and mandibular prognathism (SNA, SNB), mandibular plane angle (SN/MP), and mandibular lengths. A logistic regression model was created using the statistically significant predictors.

Results: The logistic regression analysis revealed a statistically significant impact of β angle and distance between gonion and gnathion (Go-Gn) on the level of lower third molar eruption ($P < .001$ and $P < .015$, respectively). The retromolar space was significantly increased in the adult subgroup for all skeletal classes. The lower third molar impaction rate was significantly higher in the adult subgroup with the Class II (62.3%) compared with Class III subjects (31.7%; $P < .013$).

Conclusion: The most favorable values of linear and angular predictors of mandibular third molar eruption were measured in Class III subjects. For valid estimation of mandibular third molar eruption, certain linear and angular measures (β angle, Go-Gn), as well as the size of the retromolar space, need to be considered. (*Angle Orthod.* 2015;85:577–584.)

KEY WORDS: Lower third molar; Impaction; Radiographic predictors

INTRODUCTION

Third molars account for 98% of all impacted teeth, and lower third molars are the second most frequently impacted teeth after upper third molars.[1] Prophylactic surgical removal is often suggested to avoid potentially severe complications of this condition.[2] Although indications for prophylactic removal of lower third molars are limited,[3] they continue to be a contentious point of discussion.[4]

Oral surgeons and orthodontists recommend prophylactic removal of third molars before roots are fully formed and further indicate that this procedure will prevent the eruption of the teeth in a malposition.[5] From that point of view, it is of interest to investigate which parameters might be used for the early prediction of lower third molar eruption. During the past decades, extensive research has been conducted in this field because of the high rate of third molar impaction and controversial results regarding potential predictors.[6–13]

The lower third molar eruption is a complex process that depends on several factors. For a long time, insufficient development of retromolar space has been considered to be the most important factor contributing to the high impaction rate of lower third molars.[6–8,10] However, several researchers have concluded that

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Accepted: August 2014. Submitted: June 2014.
Published Online: September 22, 2014

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even in cases with adequate retromolar space, some lower third molars might fail to erupt,[7,14] indicating that there are other factors affecting this process.

Besides retromolar space, researchers investigated the correlation between growth in length of the mandible and the risk of impaction.[14–18] Several studies reported a higher risk of lower third molar impaction in subjects with shorter mandibular length.[6,14,15] As the final results among researchers were surprisingly controversial,[15–18] it was interesting to establish whether the distances between anthropologic landmarks might be useful in the prediction of lower third molar impaction. Also, several radiographic angular measurements were proposed with a similar aim.[10,11,14,19,20] It was pointed out that excessive initial mesial angulation and minimal uprighting during follow-up might increase the likelihood of lower third molar impaction.[14]

Apart from these linear and angular indicators, patient age is an important factor, which should be considered in relation to the eruption of lower third molars. Ganss et al.[21] and Niedzielska et al.[9] did not find a significant increase in retromolar space size after the age of 16 years, while Chen et al.[12] reported its moderate expansion from ages 16 through 18 years. The longitudinal study by Kruger et al.[22] confirmed that positional changes of third molars after the age of 18 years led to their eruption. These positional changes have been explained by further skeletal growth, which might contribute to the increase of retromolar space.[22] Moreover, Janson and coworkers[23] showed that available retromolar space could differ between Class II and Class I sides, indicating that sagittal skeletal relationships might also affect the fate of these teeth. Interestingly, it was reported that differences in the impaction rate of third molars in various anteroposterior skeletal relations were more obvious after the age of 18 years.[14]

In previous studies, certain radiographic predictors for the evaluation of lower third molar eruption were not thoroughly investigated with regard to different skeletal patterns and patient age.[14,18,23] For this reason, the aim of our study was to analyze radiographic predictors for lower third molar eruption among subjects with different anteroposterior skeletal relations and of different age-related subgroups.

MATERIALS AND METHODS

The study was performed on diagnostic digital orthopantomograms (DPTs) and lateral cephalograms (LCs) available in the archive of the Clinic of Orthodontics, School of Dental Medicine, University of Belgrade. The Ethical Committee of the School of Dental Medicine, University of Belgrade, approved the study protocol (No. 36/14–2013).

A total of 300 lower third molars in 160 white subjects of Serbian population were enrolled in the study. None of the subjects had a history of previous orthodontic or orthognathic surgical treatment, and no patient had extracted or missing permanent teeth. All of the enrolled subjects were at least 16 years of age and had full dental arches with radiographically confirmed lower third molars. Individuals with developmental anomalies, dentofacial deformities, or severe facial asymmetries were excluded from the study. Those with poor quality DPTs and LCs were also excluded.

All the participants were divided into three groups according to their ANB angle[18] as measured on LCs: skeletal Class I (ANB 1°–5°), skeletal Class II (ANB more than 5°), and skeletal Class III (ANB less than 1°). All of the participants were further classified into two age-related subgroups: early adults (from 16 to 18 years) and adults (from 19 to 28 years). Also, all of the participants in three skeletal classes were subclassified into the subgroups with impacted or erupted lower third molars. The lower third molars were considered as erupted if they had reached the occlusal plane drawn on the orthopantomogram; otherwise, they were considered as impacted.[10,11]

All of the radiographs were taken through use of a standardized technique by means of a Planmeca device (Promax, Helsinki, Finland). A single investigator traced and landmarked all the radiographs by hand as defined in Table 1 and shown in Figures 1 and 2.

Statistical analysis was performed using IBM SPSS Statistics for Window Software (version 20.0, IBM Corp, Armonk, NY). Independent Student's *t*-test was used to compare the outcome variables between the age- and impaction-related subgroups for the variables with normal distribution. Variables with nonnormal distribution were compared using the Mann-Whitney *U*-test. Differences in the values of certain variables between different skeletal classes were determined by analysis of variance, while Bonferroni's multiple comparison (equal variances) and Dunnett's test (unequal variances) were applied to identify which of the groups were different. Statistical differences between frequencies were tested with Pearson's χ^2 test. *P* values less than .05 were considered statistically significant.

Univariate logistic analysis was used to determine statistically significant predictors for level of mandibular third molar eruption. Predictors with logical influence on the level of mandibular third molar eruption were included in the model. The age and the skeletal classes, as variables, were included in final regression model just for adjustment.

The intraobserver correlation coefficient was used to assess reliability and reproducibility between repeated

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Table 1. Definition of Linear and Angular Radiographic Measurements as Depicted in Figures 1 and 2

Measurement	Definition
ML	Mandibular line: tangential line of the lower border of the mandibular body
MP	Mandibular plane: line that passes through gonion and menton
OP	Occlusal plane: line drawn through the highest points of the crowns of the lateral incisor and first molars
TL	Tangent line: drawn to the most distal points on the crown and root of the second lower molar
Linear	
RMS, (mm)	Retromolar space: length of the line drawn along the occlusal plane from the point it bisects TL to the point it bisects the anterior edge of the ramus
MDW, (mm)	Mesiodistal width: the greatest distance between the mesial and distal surface of the lower third molar crown
SWR	Retromolar space/mesiodistal width ratio: calculated by dividing the RMS and MDW
Go-Gn, mm	Distance between gonion and gnathion, effective length of mandible
Ar-Go, mm	Distance between articulare and gonion, effective length of ramus
Ar-Gn, mm	Distance between articulare and gnathion
Angular	
α angle, °	Alpha angle: angulation of lower third molar to mandibular line
β angle, °	Beta angle: inclination between lower third and second molars
γ angle, °	Gamma angle: angulation of lower second molar to mandibular line
Go angle, °	Gonial angle: formed between tangent line to the posterior border of the mandibular ramus and the tangent line to the lower border of mandibular corpus
SNA angle, °	Angle between cranial base to subspinale (A-point)
SNB angle, °	Angle between cranial base to supramentale (B-point)
SN/MP angle, °	Mandibular plane to cranial base angle
ANB angle, °	Difference between SNA and SNB

measurements. Twenty randomly selected LCs and orthopantomograms were retraced and remeasured by the same examiner at least 1 week after the previous measurement.

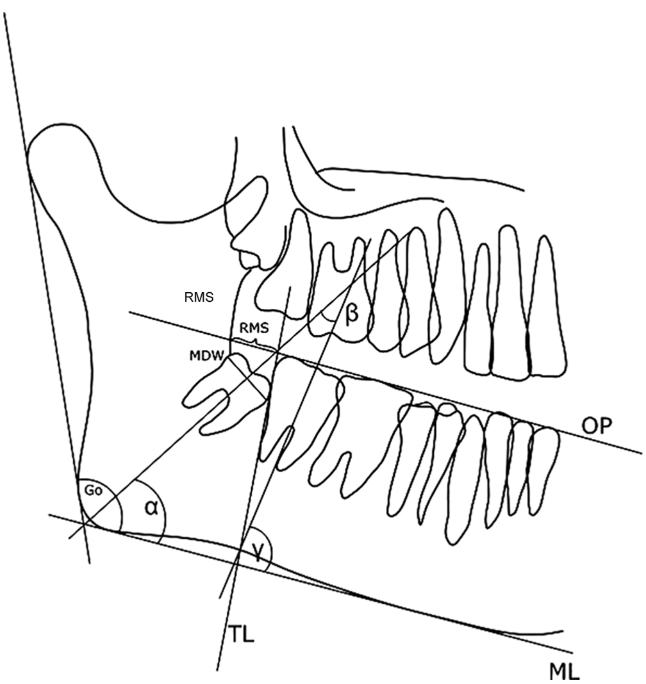

Figure 1. Linear and angular measurements used for orthopantomogram analysis. MDW indicates mesiodistal width of the lower third molar crown; RMS, retromolar space; α, angle α; β, angle β; γ, angle γ; Go, gonial angle; ML, mandibular line; OP, occlusal plane; TL, tangent line.

RESULTS

The sample consisted of 300 lower third molars of 160 patients (70 males and 90 females). The age of the participants ranged from 16 to 28 years, with a mean age of 22.5 years (±5.5 years). Each of the skeletal class groups consisted of 100 lower third molars.

The results for all investigated parameters, except for the mesiodistal crown width of the lower third molar, were significantly different between skeletal classes (Table 2). Retromolar space and space/width ratio were the largest in Class III and the smallest in Class II subjects, with statistical significance between the groups. The α, γ, and gonial angle were increased in Class III compared with Class II subjects. The β angle was the lowest in Class III subjects and the highest in Class II subjects. The linear measurements of mandibular length were the largest in Class III subjects and the smallest in Class II subjects. These differences proved to be statistically significant (Table 2).

Considering two age-related subgroups, retromolar space, space/width ratio, and Ar-Go distance were significantly increased in the adult subgroup in contrast to β and gonial angles, which were significantly decreased (Table 3).

Retromolar space was significantly increased in the adult subgroup for all skeletal classes. Only in Class III subjects of the adult subgroup was space/width ratio favorable for the lower third molar eruption. In Class III subjects of the adult subgroup, the β angle was significantly decreased while the α angle was increased. The distances between landmarks Ar-Go

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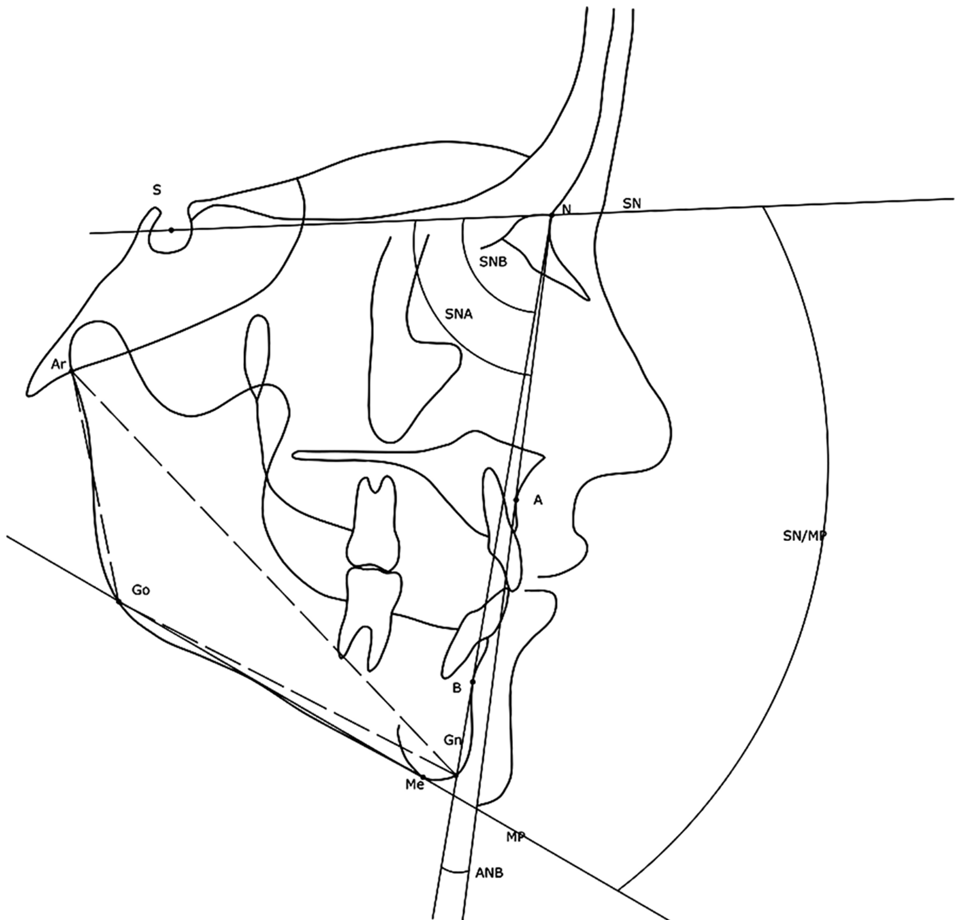

Figure 2. Points and linear and angular measurements used for lateral cephalogram analysis. S indicates sella; N, nasion; A, A point; B, B point; Gn, gnathion; Go, gonion; Ar, articulare; Me, menton; ANB, ANB angle; SNA, SNA angle; SNB, SNB angle; SN/MP, SN/MP angle; MP, mandibular plane.

and Ar-Gn were increased among the Class III subjects of the adult subgroup (Table 3). The results of all investigated parameters were, as expected, higher in the subgroup of erupted lower third molars for all three skeletal classes (Table 3).

Retromolar space and space/width ratio were significantly increased in the group with an SN/MP angle greater than 33°. Furthermore, the α angle was significantly increased in the same group. On the other hand, the β angle was decreased in the group with the

Table 2. Linear and Angular Measurements in Skeletal Classes I, II, and III[a]

Variable	Class I Mean ± SD	Class II Mean ± SD	Class III Mean ± SD	P	I–II P	I–III P	II–III P
MDW, mm	10.10 ± 1.66	11.03 ± 1.74	11.36 ± 1.43	NS	NS	NS	NS
RMS, mm	9.93 ± 3.04	8.53 ± 3.18	10.37 ± 3.0	.003**	NS	.002**	.002**
SWR	0.83 ± 0.28	0.78 ± 0.31	0.93 ± 0.33	.001***	NS	.001***	.001***
α angle, °	72.65 ± 21.59	66.64 ± 21.53	84.48 ± 15.37	.001***	NS	NS	.014**
β angle, °	21.67 ± 21.61	23.34 ± 23.28	13.84 ± 18.56	.002**	NS	.001***	.001***
γ angle, °	94.35 ± 6.14	90.92 ± 6.15	95.82 ± 11.43	.015*	NS	.020*	.002**
Go angle, °	124.70 ± 7.04	124.35 ± 7.61	129.21 ± 8.33	.001***	NS	.001***	.001***
Go-Gn, mm	75.84 ± 5.83	73.48 ± 6.29	79.49 ± 6.14	.001***	.019**	.001***	.001***
Ar-Go, mm	47.24 ± 6.29	45.75 ± 5.65	50.17 ± 6.15	.001***	NS	.001***	.001***
Ar-Gn, mm	108.85 ± 9.99	101.40 ± 9.51	114.35 ± 11.43	.001***	.001***	.001***	.001***

[a] Analysis of variance. NS indicates not significant. For a description of the variables, refer to Table 1.
* $P < .05$; ** $P < .01$; *** $P < .001$.

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Table 3. Linear and Angular Measurements Between the Age- and Impaction-Related Subgroups of Skeletal Classes I, II, and III[a]

Variable	Early Adult Mean ± SD	Adult Mean ± SD	P	Erupted Mean ± SD	Impacted Mean ± SD	P
Total sample						
MDW, mm[b]	11.02 ± 1.88	11.27 ± 1.18	NS	11.56 ± 1.01	10.95 ± 1.78	NS
RMS, mm[c]	8.82 ± 2.86	10.44 ± 3.46	.001***	12.20 ± 2.96	8.37 ± 2.60	.001***
SWR[c]	0.74 ± 0.29	0.93 ± 0.32	.001***	1.07 ± 0.30	0.75 ± 0.26	.001***
α angle, °[c]	72.54 ± 16.52	77.20 ± 25.55	NS	93.73 ± 13.56	66.34 ± 18.10	.001***
β angle, °[b]	23.07 ± 17.46	15.87 ± 25.61	.001***	3.19 ± 18.88	27.13 ± 18.58	.001***
γ angle, °[b]	93.83 ± 14.28	93.52 ± 9.08	NS	94.76 ± 13.93	93.24 ± 11.51	.048*
Go angle, °[c]	127.38 ± 8.01	124.30 ± 7.61	.001***	126.73 ± 8.20	125.75 ± 7.88	NS
Go-Gn, mm[c]	76.28 ± 5.92	76.26 ± 7.33	NS	78.57 ± 7.17	75.29 ± 6.03	.001***
Ar-Go, mm[c]	46.65 ± 4.89	49.12 ± 9.7	.001***	50.49 ± 6.19	46.53 ± 5.20	.001***
Ar-Gn, mm[b]	109.95 ± 10.32	109.11 ± 13.25	NS	114.46 ± 12.50	107.50 ± 10.66	.001***
Skeletal Class I						
MDW, mm[b]	10.98 ± 1.84	11.02 ± 1.29	NS	11.49 ± 0.95	10.84 ± 1.80	.026*
RMS, mm[c]	8.56 ± 2.98	10.70 ± 2.68	.001***	12.27 ± 1.97	8.40 ± 2.71	.001***
SWR[c]	0.76 ± 0.27	0.96 ± 0.23	.001***	1.08 ± 0.20	0.75 ± 0.25	.001***
α angle, °[c]	71.22 ± 15.94	74.94 ± 29.2	NS	95.27 ± 17.40	65.39 ± 17.48	.001***
β angle, °[b]	24.57 ± 15.84	16.50 ± 28.73	NS	0.31 ± 18.23	28.41 ± 17.95	.001***
γ angle, °[b]	95.70 ± 8.98	91.94 ± 8.14	.041*	95.17 ± 7.71	94.09 ± 9.19	NS
Go angle, °[c]	126.34 ± 7.01	121.78 ± 6.17	.002**	126.38 ± 8.07	124.17 ± 6.66	NS
Go-Gn, mm[c]	75.98 ± 5.97	75.60 ± 5.64	NS	77.24 ± 5.71	75.40 ± 5.83	NS
Ar-Go, mm[c]	46.78 ± 4.84	48.10 ± 6.45	NS	48.05 ± 6.88	47.00 ± 4.99	NS
Ar-Gn, mm[b]	109.62 ± 10.53	104.5 ± 8.95	NS	112.41 ± 11.42	107.73 ± 9.30	.045*
Skeletal Class II						
MDW, mm[b]	10.77 ± 2.28	11.26 ± 1	NS	11.71 ± 0.92	10.86 ± 1.85	.050*
RMS, mm[c]	8.15 ± 2.73	9.48 ± 3.44	.035*	12.86 ± 2.34	7.85 ± 2.51	.001***
SWR[c]	0.72 ± 0.32	0.83 ± 0.29	NS	1.09 ± 0.21	0.70 ± 0.28	.001***
α angle, °[c]	64.01 ± 14.51	68.97 ± 26.16	NS	91.10 ± 11.09	60.53 ± 19.03	.001***
β angle, °[b]	27.4 ± 16.62	21.61 ± 27,78	NS	−1.40 ± 12.36	30.78 ± 20.81	.001***
γ angle, °[b]	90.51 ± 17.0	91.28 ± 9.63	NS	91.10 ± 7.31	90.88 ± 14.72	NS
Go angle, °[c]	125 ± 7.73	123.56 ± 7.51	NS	123.85 ± 6.68	124.33 ± 7.86	NS
Go-Gn, mm[c]	73.88 ± 5.18	73.12 ± 7.17	NS	76.61 ± 8.75	72.70 ± 5.31	NS
Ar-Go, mm[c]	45.41 ± 4.91	46.05 ± 6.27	NS	48.22 ± 6.06	45.13 ± 5.41	.028*
Ar-Gn, mm[b]	104.51 ± 8.25	102.2 ± 10.46	NS	107.17 ± 12.66	102.32 ± 8.37	.041*
Skeletal Class III						
MDW, mm[b]	11.27 ± 1.53	11.49 ± 1.26	NS	11.53 ± 1.10	11.21 ± 1.65	NS
RMS, mm[c]	9.62 ± 2.67	11.45 ± 3.81	.010**	11.89 ± 3.56	9.09 ± 2.43	.001***
SWR[c]	0.87 ± 0.27	1.03 ± 0.38	.018*	1.06 ± 0.37	0.83 ± 0.25	.001***
α angle, °[c]	80.76 ± 14.91	89.8 ± 14.6	.003**	94.07 ± 12.35	76.31 ± 12.79	.001***
β angle, °[b]	18.0 ± 18.8	7.88 ± 16.73	.007**	6.70 ± 21.09	19.93 ± 13.56	.001***
γ angle, °[b]	94.4 ± 16.3	97.79 ± 7.73	NS	96.13 ± 17.98	95.55 ± 8.09	NS
Go angle, °[c]	130.4 ± 8.43	127.49 ± 7.96	NS	128.17 ± 8.67	130.09 ± 8.00	NS
Go-Gn, mm[c]	78.53 ± 5.69	80.88 ± 6.56	NS	80.11 ± 6.90	78.96 ± 5.42	NS
Ar-Go, mm[c]	47.5 ± 4.8	54.02 ± 5.58	.001***	52.75 ± 5.03	47.97 ± 6.01	.001***
Ar-Gn, mm[b]	114.63 ± 9.47	119.48 ± 13.37	.036*	118.70 ± 11.42	114.84 ± 11.22	NS

[a] NS indicates not significant. For a description of the variables, refer to Table 1.
[b] Mann-Whitney *U*-test.
[c] Student's *t*-test.
* $P < .05$; ** $P < .01$; *** $P < .001$.

SN/MP angle larger than 33°, but that difference was not statistically significant (Table 4).

The final regression model included two parameters. According to presented logistic regression analysis, the β angle and distance between the landmarks Go-Gn had a statistically significant impact on the level of lower third molar eruption (Table 5). Variability of the final regression model was 64% ($r^2 = .64$). All presented results contribute to a higher impaction rate among the subgroup of Class II adults (62.3%), which was contrary to the lower impaction rate of the Class III subjects (31.7%). Significant differences were observed between these groups (Table 6).

The interclass correlation coefficient analyzed among repeated linear and angular measurements revealed a high level of reliability and reproducibility for both radiographic measurements ($P < .001$).

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Table 4. Values of Linear and Angular Measurements in Groups With Different SN/MP Angle Values[a]

Variable	SN/MP Angle Mean ± SD $\leq 32^\circ$	$\geq 33^\circ$	P
RMS, mm[b]	9.05 ± 3.11	9.85 ± 3.28	.034*
SWR[b]	0.80 ± 0.29	0.88 ± 0.33	.028*
α angle, °[b]	70.95 ± 21.21	77.14 ± 20.53	.012*
β angle, °[c]	20.62 ± 21.59	19.47 ± 21.72	NS

[a] NS indicates not significant. For a description of the variables, refer to Table 1.
[b] Student's *t*-test.
[c] Mann-Whitney *U*-test.
* $P < .05$.

DISCUSSION

The possibility of mandibular third molar eruption depends on several factors. It has been suggested that different skeletal relationships might have an impact on this process.[14,18,23] This influence remained unclear because the presented results were conflicting.

The lack of retromolar space was presented as one of the most important factors that causes a high impaction rate among mandibular third molars.[6–13] Our results indicate that retromolar space and space/width ratio were significantly larger in the subgroup of erupted mandibular third molars ($P < .001$). Furthermore, significantly larger sizes of retromolar space and space/width ratio were observed in the adult rather than in the early adult subgroup of patients ($P < .001$). These results are in line with those of Chen et al.[12] and Zelic and Nedeljkovic,[13] who suggested that retromolar spaces expand after the age of 16 years. It is possible that such expansion is related to resorption of the anterior edge of the mandibular ramus,[10] which is supported by the fact that in our study, the increased SN/MP angle was related to higher values of retromolar space, space/width ratio, and α angle (Table 4). Furthermore, despite the increase in retromolar space and space/width ratio, linear measurements of mandibular length did not change significantly between the early adult and adult subgroups (Table 3).

Although the space/width ratio has increased in adult patients, such phenomenon has not been observed in all skeletal classes. Only in Class III patients did the space/width ratio reach favorable values for third molar eruption. Janson et al.[23] reported less space for mandibular third molars on the Class II sides compared with Class I sides. Similarly, we observed the greatest lack of space among Class II subjects. On the other hand, the greatest available retromolar space was found in Class III subjects. We support the opinion of Janson et al.[23] that the distal position of the first mandibular molar and shorter mandibular length in skeletal Class II might be the cause of differences between skeletal Classes II and III. The results of another study, conducted in a Jordanian population, are opposite to our findings.[18] Abu Alhaija et al.[18] revealed the greatest lack of retromolar space among Class III subjects and the highest percentage of lower third molar impaction compared with skeletal Classes I and II. The patterns of facial growth, jaw development, and tooth size are inherited and differ between populations and races.[7] We assume that different genetic backgrounds might be the reasonable explanation for opposite results, although similar methodology was used.

Table 5. Linear and Angular Variables With Significant Effect on Level of Mandibular Third Molar Eruption According to Univariate Logistic Regression Analysis in the Adult Subgroup of Patients[a]

Variable	Odds Ratio (95% CI)	P
β angle	1.103 (1.061–1.146)	.001***
Go-Gn	0.934 (0.835–1.046)	.015*

[a] NS indicates not significant; CI, confidence interval. For the description of the variables, refer to Table 1.
* $P < .05$; *** $P < .001$.

Table 6. Results of Chi-Square Test to Evaluate the Eruption of Mandibular Third Molars in the Adult Group With Different Skeletal Classes

$\chi^2 = 8637$; $P = .013$*			Mandibular Third Molar Eruption: Erupted	Impacted	Total
Skeletal Class	Class I	n	19	17	36
		%	52.8	47.2	100.0
	Class II	n	20	33	53
		%	37.7	62.3	100.0
	Class III	n	28	13	41
		%	68.3	31.7	100.0
	Total	n	67	63	130
		%	51.5	48.5	100.0

* $P < .05$.

The effective lengths of mandibular corpus and ramus were correlated with the impaction rate of mandibular third molars.[12,14–18] The significantly greatest values of these distances were observed among Class III subjects, and they were significantly decreased in the subgroup of Class II subjects ($P < .001$). These findings are in accordance with previously reported results.[10,14] Furthermore, mandibular lengths were significantly increased in the subgroup of patients with erupted mandibular third molars ($P < .001$). On the other hand, Kaplan[16] and Dierkes[17] did not observe differences in mandibular lengths between impacted and erupted mandibular third molars. Also, Abu Alhaija et al.[18] did not record any significant differences between these distances in impaction-related subgroups for all three skeletal classes. Different landmarks and radiology methods[16,17] might be the reasons for inconsistency among findings.

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Some authors have reported that a small inclination angle in the early stages of mandibular third molar development is a sign of its impaction.[14,19,20] In our study, α and γ angles were significantly increased while β angle was significantly decreased in the subgroup of patients with erupted mandibular third molars ($P < .001$). These findings are in accordance with previously reported results.[11,12,19] The mean values of angles (α, γ, and gonial) measured in our study were the highest in Class III subjects and the lowest in Class II subjects, except for the β angle, whose values were quite the reverse: lowest in Class III and highest in Class II subjects (Table 1). Besides anteroposterior skeletal relationships, it has been demonstrated that the angulation of the lower third molars might be affected by extraction of premolars.[24] Similar results were reported in studies by Janson et al.[23] and Abu Alhaija et al.[18] We support the opinion of Turkoz and Ulusoy,[25] who stated that appropriate α and β angles may maintain the necessary external force to remodel the retromolar region, thus increasing the retromolar space.

We included potential linear and angular measurements in the final logistic regression model and tried to predict their influence on mandibular third molar eruption. According to our regression model, β angle and Go-Gn distance had a significant influence on the level of mandibular third molar eruption ($P < .001$ and $P < .015$, respectively). Two earlier studies also carried out similar regressions analyses.[9,10] The main similarity between these models is the inclusion of the β angle, which showed a statistically significant impact on mandibular third molar eruption in both our study and the studies by Niedzielska et al.[9] and Behbehani et al.[10] Unlike other models, our model predicts that the Go-Gn distance has an impact on the level of mandibular third molar eruption. Our regression model also differs from other models in that it was adapted to age and skeletal class.

Our study is designed as a cross-sectional study, which might be a limitation. To accurately determine the significance of radiographic predictors in evaluating the possibility of lower third molar eruption, it is necessary to perform longitudinal studies, which follow the same subjects over a prolonged period of time. Limitations in inclusion criteria, necessity of repeated radiographic examinations, and potential loss of subjects for follow-up make such studies difficult to perform.

CONCLUSIONS

- It might be expected that the space/width ratio will increase after the age of 18 years, but not in all skeletal classes. Only in Class III patients will the space/width ratio achieve values needed for eruption of lower third molars.
- Besides retromolar space, other linear and angular measures (β angle and Go-Gn distance) are necessary for adequate estimation of mandibular third molar eruption.
- The influence of different skeletal relationships on the possibility of mandibular third molar eruption and continuous expansion of the retromolar space after the age of 16 years indicate that skeletal relations and patient age are important factors when deciding among treatment options.

ACKNOWLEDGMENTS

This work was supported by grant 175075 from the Ministry of Education, Science and Technological Development of the Republic of Serbia. The authors deny any conflicts of interest related to this study. We thank to Gordana Todorovic, professor of English language at the School of Dental Medicine, University of Belgrade, for improving the language of the manuscript.

REFERENCES

1. Dachi SF, Howell FV. A survey of 3,874 routine full-month radiographs. II. A study of impacted teeth. *Oral Surg Oral Med Oral Pathol*. 1961;14:1165–1169.
2. Adeyemo WL. Do pathologies associated with impacted lower third molars justify prophylactic removal? A critical review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2006;102:448–452.
3. National Institute for Health and Care Excellence. Guidance on the Extraction of Wisdom Teeth. NICE. 2000. Available at: http://publications.nice.org.uk/guidance-on-the-extraction-of-wisdom-teeth-ta1/review-of-guidances. Accessed March 5, 2014.
4. Hill CM. Removal of asymptomatic third molars: an opposing view. *J Oral Maxillofac Surg*. 2006;64:1816–1820.
5. Beeman CS. Third molar management: a case for routine removal in adolescent and young adult orthodontic patients. *J Oral Maxillofac Surg*. 1999;57:824–830.
6. Bjork A, Jensen E, Palling M. Mandibular growth and third molar impaction. *Acta Odont Scand*. 1956;14:231–271.
7. Hattab FN, Abu Alhaija ES. Radiographic evaluation of mandibular third molar eruption space. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1999;88:285–291.
8. Mollaoglu N, Cetiner S, Gungor K. Patterns of third molar impaction in a group of volunteers in Turkey. *Clin Oral Investig*. 2002;6:109–113.
9. Niedzielska IA, Drugacz J, Kus N, et al. Panoramic radiographic predictors of mandibular third molar eruption. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2006; 102:154–158.
10. Behbehani F, Artun J, Thalib L. Prediction of mandibular third molar impaction in adolescent orthodontic patients. *Am J Orthod Dentofac Orthop*. 2006;130:47–55.
11. Uthman AT. Retromolar space analysis in relation to selected linear and angular measurements for an Iraqi sample. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2007;104:e76–e82.
12. Chen LL, Xu TM, Jiang JH, et al. Longitudinal changes in mandibular arch posterior space in adolescents with normal occlusion. *Am J Orthod Dentofac Orthop*. 2010;137: 187–193.

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13. Zelic K, Nedeljkovic N. Size of the lower third molar space in relation to age in Serbian population. *Vojnosanit Pregl*. 2013;70:923–928.
14. Richardson ME. The etiology and prediction of mandibular third molar eruption. *Angle Orthod*. 1977;47:165–172.
15. Capelli J Jr. Mandibular growth and third molar impaction in extraction cases. *Angle Orthod*. 1991;61:223–229.
16. Kaplan RG. Some factors related to mandibular third molar impaction. *Angle Orthod*. 1975;45:153–158.
17. Dierkes DD. An investigation of the mandibular third molars in orthodontic cases. *Angle Orthod*. 1975;45:207–212.
18. Abu Alhaija ES, AlBhairan HM, AlKhateeb SN. Mandibular third molar space in different antero-posterior skeletal patterns. *Eur J Orthod*. 2011;33:570–576.
19. Haavikko K, Altonen M, Mattila K. Predicting angulational development and eruption of the lower third molar. *Angle Orthod*. 1978;48:39–48.
20. Legovic M, Legovic I, Brumini G, et al. Correlation between the pattern of facial growth and the position of the mandibular third molar. *J Oral and Maxillofac Surg*. 2008;66:1218–1224.
21. Ganns C, Hochban W, Kielbassa AM, Umstadt HE. Prognosis of third molar eruption. *Oral Surg Oral Med Oral Pathol*. 1993;76:688–693.
22. Kruger E, Thomson WM, Konthasinghe P. Third molar outcomes from age 18 to 26: findings from a population-based New Zealand longitudinal study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2001;92:150–155.
23. Janson G, Lima KJ, Woodside DG, et al. Class II subdivision malocclusion types and evaluation of their asymmetries. *Am J Orthod Dentofac Orthop*. 2007;131:57–66.
24. Saysel MY, Meral GD, Kocadereli I, Tasar F. The effects of first premolar extractions on third molar angulations. *Angle Orthod*. 2005;75:719–722.
25. Turkoz C, Ulusoy C. Effect of premolar extraction on mandibular third molar impaction in young adults. *Angle Orthod*. 2013;83:572–577.

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