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Perspective

Prediction of Mandibular Third Molar Impaction Using Linear and Angular Measurements in Young Adult Orthopantomograms

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Abstract: This retrospective study aimed to evaluate a possible correlation between the characteristics of the mandibular ramus and lower third molar impaction by comparing a group of subjects with an impacted lower third molar and a second group with normal eruption for an early prediction of this pathology. This comparison was made using linear and angular measurements, which were taken on digital panoramic radiographs. **Materials and methods:** A total of 726 orthopantomographs (OPT) were examined, and 81 were considered suitable for the present study. The results were divided into two groups: a control group and an experimental group. The control group comprised 38 cases in which patients had at least one lower third molar that had erupted, and the experimental group comprised 43 cases in which patients had at least one lower third molar that was impacted or partially impacted. In total, 16 variables (11 linear, 4 angular, and 1 ratio) were determined and measured by an experienced observer. **Results:** The control group had a larger retromolar space, a larger impaction angle and a higher ratio of retromolar area to the third molar, compared to the experimental group. In contrast, the experimental group showed a deeper sigmoid notch depth than the control group did. In the control group, moderate positive correlations were found between both the length of the coronoid and the width of the third molar, and the retromolar space. Furthermore, in the experimental group, moderate positive correlations were found between both the angular condyle–coronoid process and the inclination of the lower posterior teeth, and the retromolar space. **Conclusion:** this study showed that the angle of a lower third molar, in relation to mandibular pain, can be an index for predicting tooth inclusion.

Keywords: third molar impaction; mandibular ramus dimensions; molar inclusion

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1. Introduction

The inclusion of lower third molars has always represented a complex situation in dentistry. This occurs in about 73% of young adults in Europe [1–5].

However, the eruption of third molars can vary based on race and other factors such as diet, genetics, and the degree of tooth usage [6].

In fact, these are the teeth that most often undergo bone inclusion [1–9] and this can lead to complications in surgical treatment—given the possible risks of such a procedure [10]—and in the stability of possible orthodontic treatment.

The physiological eruption of the third molar occurs between the ages of 17 and 24 years [11]. Third molar retention can manifest itself with different clinical conditions: complete bone impaction, osteomucosal impaction and mucosal impaction.

The phenomenon of bone inclusion can be the cause of suppurative pericoronaritis or can be totally asymptomatic. Impacted third molars can lead to the development of cysts and tumors, which can cause significant damage to the jawbone and surrounding teeth. A study published in 2014 by Steed MB et al. found that impacted wisdom teeth were associated with cysts and tumors, although they are relatively rare, highlighting the importance of the early detection and removal of impacted third molars [4]. The impacted lower third molars are also extracted more commonly due to dental caries involving either the impacted third molar itself or the distal surface of the second molar [5].

However, in a study that was conducted in 2020 by Ghaeminia et al. [12], it was concluded that "Insufficient evidence was found to support or refute routine prophylactic removal of asymptomatic impacted wisdom teeth in adults. A single trial comparing removal versus retention found no evidence of a difference on late lower incisor crowding at 5 years; however, no other relevant outcomes were measured. Watchful monitoring of asymptomatic third molar teeth may be a more prudent strategy".

Furthermore, a major revision was previously published by G. Mettes [13] in The Cochrane Library, 2012. This manuscript was concluded by stating that "insufficient evidence was found to support or refute routine prophylactic removal of asymptomatic impacted wisdom teeth in adults. A single trial comparing removal versus retention found no evidence of a difference on late lower incisor crowding at 5 years; however, no other relevant outcomes were measured. Watchful monitoring of asymptomatic third molar teeth may be a more prudent strategy".

The extraction of the lower third molar can be the cause of different complications. For example, in 2016, a study was published by Jessica Yolanda Jeevitha [14] and revealed that it is possible to observe fractures on the mandible either intraoperatively or in four weeks, postoperatively. This was also highlighted by Bodner et al. [15] in 2011.

In 2022, Boffano P. et al. [16] published a manuscript in which they concluded that the "inadequate management of surgical instruments, the application of excessive force, incorrect surgical technique, underestimating the difficulty of the extraction, not performing the correct odontosection of the lower third molar and performing extensive ostectomies may be some of the causes of iatrogenic fractures".

An important complication that can arise from the extraction of a lower third molar when it is impacted on the seventh tooth is the secondary presence of an empty space close to the distal root of the seventh tooth. This empty space leaves the distal root of the seventh tooth completely or partially exposed. An in vitro study was published in 2022 by Bambini F. [17], which investigated how to support bone regeneration in this area. In their study, they tested the dentin—which could be used as a filler in the postextraction alveolus of the tooth for the preservation of the dental socket that was derived from the trituration of the dentin of an extracted eighth tooth. Another approach for preserving the alveolus was published by both Rossi et al. [18,19] and by Grassi et al. [20], in 2022. In these studies, they investigated alveolar preservation using bovine cortical lamina and fibrin glue.

The etiology of third molar inclusion is still under discussion; however, craniofacial development is certainly an important aspect of third molar inclusion [21], as inclusion is often associated with poor growth in the length of the mandible [4–7]; therefore, it is associated with a type II skeletal class [22]. Consequently, it is also important to consider the decrease in the space between the lower second molar and the mandibular ramus.

These factors occur due to a change in craniofacial growth during the developmental process, as a result of a decrease in the masticatory activity of the maxillary bones, which thus causes a decrease in their development. Another demographic factor that has been implicated in the etiology of impacted wisdom teeth is age. A systematic review and meta-analysis by Chen, Y.W., et al. (2017) demonstrated that older age was a significant risk factor for impacted wisdom teeth, with the highest prevalence of impaction occurring in patients over the age of 25. The authors proposed that older age may result in increased bone density and decreased jawbone size, contributing to the development of impaction [23].

In addition to morphological and demographic factors, a significant genetic component has also been identified in the etiology of impacted wisdom teeth. In a twin study, Trakinienė G et al. (2018) reported heritability estimates ranging from 40 to 60% for the development of impacted wisdom teeth. The authors suggested that the genetic contribution may be due to the influence of genetic factors on tooth size and jaw size [24]. Lastly, poor oral hygiene can also increase the risk of impaction. Caymaz, M.G. et al. (2021) found that patients with impacted wisdom teeth were more likely to have periodontitis and gingivitis compared to patients without impacted wisdom teeth. The authors proposed that poor oral hygiene may lead to an increase in the risk of impaction by creating an environment that is conducive to bacterial growth [25].

OPTs are extensively utilized in the field of dentistry due to their ability to offer a swift, cost-effective, and low radiation dosage option, while also providing a bilateral perspective of the mandible, unlike more complex diagnostic instruments). Furthermore, it is regarded as a suitable radiographic approach for evaluating the space occupied by the lower third molar and the linear and angular dimensions of the mandible [2,26].

This retrospective radiograph study aimed to evaluate a possible correlation between the characteristics of the mandibular ramus and lower third molar inclusion by comparing a group of subjects with lower third molar inclusion to a second group with normal eruption to establish an early means of predicting this pathology. The comparison was made using linear and angular measurements taken on digital panoramic radiographs [2].

2. Materials and Methods

This study was carried out as a retrospective radiographic research study and was performed in a private clinic (A.G., E.M.), in compliance with the principles of the Declaration of Helsinki, on medical protocol and ethics.

Orthopanoramic radiographs taken in the period between January 2015 and December 2021 were considered.

A total of 726 OPTs were examined, but only 81 were suitable for the present study considering the following evaluation criteria: patients with included or erupted lower third molars, no history of pathology associated with third molars, no previous orthodontic treatment, complete formation of the tooth's root and good OPT quality [27].

The radiographs were all taken on the Carestream C8100 3D CBCT digital radiography machine, with an OPT function.

We analyzed both sides of the maxillary bones indiscriminately. We only considered the side that was included in the selection criteria.

OPTs with one side of the third molar impacted and the other side fully erupted were excluded.

The radiographs included patients aged between 18 and 25 years old, of both sexes (50 male and 31 female).

The results were divided into 2 groups:

Group A: control group comprising 38 cases with at least one lower third molar erupted.

Group B: experimental group comprising 43 cases with at least one lower third molar included or partially included and, therefore, not in functional occlusion.

Groups were further divided into male and female groups, male experimental group B (MB) (n = 24), male control group A (MA) (n = 26), female experimental group B (FB) (n = 19) and female control group A (FA) (n = 12), and were compared with their equivalent subgroups in the control group.

Interpretation of the digital panoramic radiographic images was performed using Carestream Dental Imaging Software.

Using the digital ruler and protractor functions, 16 variables (11 linear, 4 angular and 1 ratio) were determined and measured by an experienced observer (Figures 1 and 2) [1–9,21,28–33].

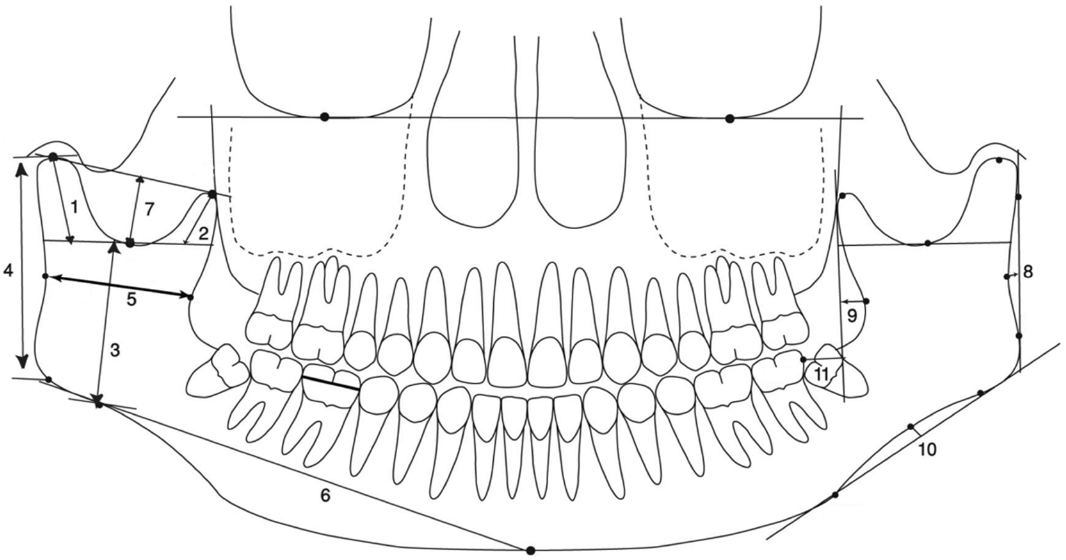

Figure 1. Linear measurements.

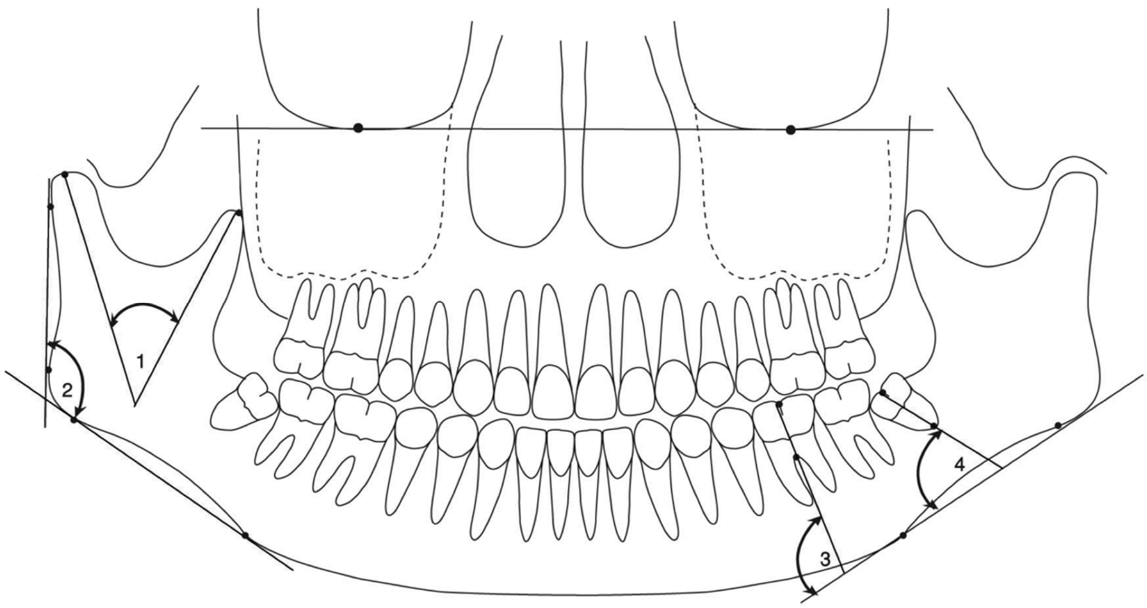

Figure 2. Angular measurements.

The 11 linear measurements are represented in Figure 1 and listed in Table 1 with their corresponding numbers:

1. Condyle length from the highest point of the mandibular condyle's head to lowest point of the mandibular sigmoid notch plane, along the long axis of the condylar process.
2. Coronoid length from the highest point of the mandibular coronoid process to the lowest point of the mandibular sigmoid notch plane, along the long axis of the coronoid process.
3. Ramus height from the lowest point of the mandibular sigmoid notch to the point in the antegonial notch of the mandible, the ramus and body of the mandible are joined.
4. Total ramus height from the highest point of the mandibular condyle's head to the intersection point of the ramus plane and the mandibular plane.
5. Ramal width from the deepest point of the anterior ramus notch concavity to the deepest point of the posterior ramus notch concavity.
6. Mandibular body length from the intersection point of the ramus plane and the mandibular plane to the midpoint of the mandible.

7. Sigmoid notch depth: the perpendicular line from the lowest point of the mandibular sigmoid notch to a line from the condylion and coronoid process.
8. Posterior ramus notch depth from the perpendicular line from the deepest point of the posterior ramus notch concavity to the line that connects the point where the external contour of the cranial base intersects with the dorsal contour of the condylar head to the point of maximal convexity on the posterior border of the angular process of the mandible.
9. Anterior ramus notch depth from the perpendicular line from the deepest point of the anterior ramus notch concavity to the perpendicolar line to the plane of the sigmoid notch and tangent to the descending anterior border of the ramus of the mandible.
10. Antegonial notch depth from the perpendicular line from the deepest point of the mandibular inferior border notch concavity to the mandibular plane.
11. Third molar width from the mesial aspect to distal aspect of third molar.

Table 1. Reference points: 13 variables (8 linear, 4 angular and 1 ratio) determined and measured.

Variable	Control Group (A)		Experimental Group (B)		*p* Value *
	Mean	SD	Mean	SD	
1. Condyle length (cm)	1.77	0.41	1.84	0.45	0.463
2. Coronoid length (cm)	1.37	0.46	1.53	0.36	0.080
3. Ramus height (cm)	6.37	0.57	6.18	0.68	0.199
4. Total ramus height (cm)	7.40	0.73	7.30	0.80	0.540
5. Ramal width (cm)	3.62	0.52	3.66	0.39	0.676
6. Mandibular body length (cm)	10.97	1.24	10.90	1.11	0.787
7. Sigmoid notch depth (cm)	1.43	0.33	1.59	0.31	**0.030**
8. Posterior ramus notch depth (cm)	0.25	0.14	0.30	0.14	0.088
9. Anterior ramus notch depth (cm)	0.27	0.22	0.24	0.19	0.490
10. Antegonial notch depth (cm)	0.23	0.24	0.20	0.15	0.515
11. Third molar width (cm)	1.38	0.27	1.41	0.14	0.424
Retromolar space (cm)	1.52	0.63	1.14	0.60	**0.007**
1. Angle condyle—coronoid process (deg)	30.13	5.35	29.53	4.81	0.599
2. Gonial angle (deg)	124.84	6.78	122.63	68.33	0.195
3.Inclination of lower posterior teeth (deg)	95.53	5.93	92.65	6.23	0.521
4. Angle of impaction (deg)	88.61	16.72	68.53	34.06	**0.002**
Retromolar space/3M width (ratio)	1.09	0.40	0.81	0.44	**0.004**

* using Student's *t*-test.

The 4 angular measurements are represented in Figure 2 and listed in Table 1 with their corresponding numbers:

1. Angle condyle—coronoid process: the intersection between the highest point of the mandibular condyle's head to the highest point of the mandibular coronoid process.
2. Gonial angle: the intersection between the line that connects the point where the external contour of the cranial base intersects with the dorsal contour of the condylar head to the point of maximal convexity on the posterior border of the angular process of the mandible and the mandibular plane.
3. Inclination of lower posterior teeth: the intersection between the mandibular plane and the long axis of the first molar.

4. Angle of impaction: the intersection between the mandibular plane and the long axis of the third molar.

Statistical Analysis

The mandibular dimensions of the sample were compared with those of the control group. Descriptive statistics, as mean and standard deviation, were used to examine the characteristics of the sample. Data analyzed were normally distributed (through a Shapiro–Wilk test), and Student's *t*-test was used to analyze the statistical differences between the two groups.

Groups were further divided into male and female groups: male impaction group B (MB) (n = 24), male control group A (MA) (n = 26), female impaction group B (FB) (n = 19) and female control group A (FA) (n = 12). The impaction groups were also compared to their equivalent subgroups in Group A using an unpaired *t*-test.

Furthermore, Pearson's correlation and linear regression tests were used to assess the degree of relationship between the retromolar space and mandibular measurements. Statistical analyses were performed using the STATA/IC 15.1 statistical package. All tests were two-tailed, and p-values of $\leq$0.05 were considered statistically significant.

3. Results

The results showed that the control group demonstrated a larger retromolar space (1.52 ± 0.63 vs. 1.14 ± 0.60, p = 0.007), a larger impaction angle (88.61 ± 16.72 vs. 68.53 ± 34.06, p = 0.002), and a higher ratio of retromolar area to the third molar (1.09 ± 0.40 vs. 0.81 ± 0.44, p = 0.004), compared to the experimental group (Table 1). In contrast, the experimental group demonstrated a deeper sigmoid notch depth (1.59 ± 0.31 vs. 1.43 ± 0.33, p = 0.030) than the control group.

In both groups, a moderate negative correlation was found between the depth of the anterior branch notch (p = 0.001 and p = 0.002, respectively) and the retromolar space. A strong positive correlation was found between both the retromolar area and the third molar ratio (p < 0.001), and the retromolar space.

In the control group, moderate positive correlations were found between both the length of the coronoid (p = 0.029) and the width of the third molar (p = 0.004). In addition, in the control group, a moderate negative correlation was found between the depth of the antegonial notch (p = 0.019) and the retromolar space.

Furthermore, in the experimental group, moderate positive correlations (p = 0.008) were found between both the angular condyle–coronoid process and the inclination of the lower posterior teeth, and the retromolar space (Table 2).

Table 2. Pearson's correlation and linear regression tests values.

Variable	Control Group (A)				Experimental Group (B)			
	Retromolar Space				Retromolar Space			
	r	R^2	R^2 (ADJ)	p Value	r	R^2	R^2 (ADJ)	p Value
Condyle length	−0.172	0.029	0.003	0.303	−0.157	0.025	0.001	0.314
Coronoid length	0.354	0.125	0.101	**0.029**	0.035	0.001	−0.023	0.826
Ramus height	0.222	0.049	0.023	0.181	0.151	0.023	−0.001	0.335
Total ramus height	0.197	0.039	0.012	0.236	0.194	0.038	0.014	0.213
Ramal width	0.307	0.095	0.069	0.061	0.025	0.001	−0.024	0.875
Mandibular body length	0.081	0.007	−0.021	0.629	−0.288	0.083	0.061	0.061
Sigmoid notch depth	0.064	0.004	−0.024	0.701	−0.149	0.022	−0.002	0.339
Posterior ramus notch depth	−0.192	0.037	0.010	0.249	0.188	0.035	0.012	0.227

Table 2. *Cont.*

Variable	Control Group (A)				Experimental Group (B)			
	Retromolar Space				Retromolar Space			
	r	R^2	R^2 (ADJ)	*p* Value	r	R^2	R^2 (ADJ)	*p* Value
Anterior ramus notch depth	−0.521	0.271	0.251	**0.001**	−0.454	0.206	0.187	**0.002**
Antegonial notch depth	−0.379	0.144	0.120	**0.019**	0.295	0.087	0.065	0.055
Third molar width	0.456	0.208	0.186	**0.004**	0.095	0.009	−0.015	0.545
Gonial angle	0.312	0.097	0.072	0.056	0.182	0.033	0.010	0.243
Angle condyle—coronoid process	0.071	0.005	−0.023	0.673	0.402	0.162	0.141	**0.008**
Inclination of lower posterior teeth	0.142	0.020	−0.007	0.396	0.397	0.157	0.137	**0.008**
Angle of impaction	0.176	0.031	0.004	0.290	0.245	0.060	0.037	0.113
Retromolar space/3M width (ratio)	0.966	0.933	0.931	**<0.001**	0.971	0.942	0.941	**<0.001**

r = Pearson correlation coefficient; R^2 = squared multiple correlation coefficient; R^2 (ADJ) = adjusted coefficient of determination.

Considering sex, male control group MA showed larger retromolar space (1.54 ± 0.59 vs. 1.10 ± 0.58, $p = 0.010$), larger angle of impaction (90.93 ± 8.69 vs. 69.46 ± 32.66, $p = 0.002$) and higher retromolar area to the third molar ratio (1.09 ± 0.39 vs. 0.77 ± 0.39, $p = 0.006$) than male experimental group MB (Table 3).

Table 3. Comparison between male group A (MA) and the male group B (MB).

Variable	Control Group (Male Group A, *n* = 26)		Experimental Group (Male Group B, *n* = 24)		*p* Value *
	Mean	SD	Mean	SD	
Condyle length (cm)	1.76	0.43	1.86	0.37	0.365
Coronoid length (cm)	1.49	0.48	1.55	0.36	0.608
Ramus height (cm)	6.43	0.52	6.13	0.67	0.087
Total ramus height (cm)	7.48	0.70	7.25	0.79	0.294
Ramal width (cm)	3.69	0.55	3.58	0.33	0.421
Mandibular body length (cm)	10.81	1.11	10.88	1.18	0.836
Sigmoid notch depth (cm)	1.47	0.36	1.60	0.29	0.137
Posterior ramus notch depth (cm)	0.24	0.13	0.30	0.16	0.110
Anterior ramus notch depth (cm)	0.26	0.19	0.24	0.18	0.656
Antegonial notch depth (cm)	0.22	0.24	0.20	0.14	0.737
Third molar width (cm)	1.39	0.12	1.41	0.15	0.608
Retromolar space (cm)	1.54	0.59	1.10	0.58	**0.010**
Angle condyle—coronoid process (deg)	31.04	5.38	28.75	5.06	0.129
Gonial angle (deg)	124.81	7.48	122.33	8.76	0.287
Inclination of lower posterior teeth (deg)	91.15	5.70	92.70	6.65	0.753
Angle of impaction (deg)	90.93	8.69	69.46	32.66	**0.002**
Retromolar space/3M width (ratio)	1.09	0.39	0.77	0.39	**0.006**

* using Student's *t*-test.

Female experimental group FB showed higher coronoid length (1.50 ± 0.37 vs. 1.10 ± 0.28, $p = 0.004$) than female control group (FA) (Table 4).

Table 4. Comparison between female group A (FA) and group B (FB).

Variable	Control Group (Female Group A, *n* = 12)		Experimental Group (Female Group B, *n* = 19)		*p* Value *
	Mean	**SD**	**Mean**	**SD**	
Condyle length (cm)	1.81	0.36	1.82	0.53	0.943
Coronoid length (cm)	1.10	0.28	1.50	0.37	**0.004**
Ramus height (cm)	6.23	0.67	6.25	0.70	0.930
Total ramus height (cm)	7.23	0.77	7.35	0.82	0.688
Ramal width (cm)	3.46	0.41	3.75	0.45	0.077
Mandibular body length (cm)	11.32	1.48	10.93	1.04	0.396
Sigmoid notch depth (cm)	1.35	0.23	1.56	0.33	0.069
Posterior ramus notch depth (cm)	0.27	0.17	0.30	0.13	0.537
Anterior ramus notch depth (cm)	0.28	0.26	0.24	0.20	0.584
Antegonial notch depth (cm)	0.25	0.25	0.20	0.16	0.505
Third molar width (cm)	1.35	0.46	1.42	0.13	0.525
Retromolar space (cm)	1.49	0.76	1.19	0.65	0.255
Angle condyle—coronoid process (deg)	28.17	4.95	30.53	4.41	0.177
Gonial angle (deg)	124.92	5.23	123.00	7.83	0.461
Inclination of lower posterior teeth (deg)	96.50	5.50	92.58	5.81	0.072
Angle of impaction (deg)	83.58	26.98	67.37	36.62	0.197
Retromolar space/3M width (ratio)	1.07	0.45	0.85	0.50	0.240

*: using Student's *t*-test.

4. Discussion

Various studies have been carried out on the predictability of the eruption of the mandibular lower third molar, based on the size of the bony structures of the mandible. These studies have been conducted using both lateral cephalometric and orthopanoramic radiographs; however, not many authors have compared the different radiographic techniques [21,26,28–33] for mandibular measurements. The few authors who have compared the different techniques have found excellent results when using both methods. Therefore, they have concluded that they are both valid tools for diagnostic investigation in this area and that the choice between them depends on the experience of the clinician. They are routinely used in dentists' normal professional practice [23] both to obtain an initial general diagnosis of a patient's oral health status and for more in-depth examinations of third molar inclusion, for which digital orthopanoramic examinations are also used.

The subjects were selected upon the consideration that an age between 18 to 25 years of age is the average age of eruption and complete formation of the mandibular third molar. Various studies have reported [29–31] that the ideal age for studying the incidence of the lower third molar is between 20 and 25 years. In total, 81 subjects were considered, and the age range was extended to between 18 and 25 years of age, on the condition that the tooth's root had been completely formed.

In our study, we found that the length of the condyle–coronoid process in the experimental group was greater than that in the control group. This result was partially in agreement with that of Capelli [5], who found an association between a greater ascending ramus size and the inclusion of the lower third molar.

In contrast, the height of the branch and its total size were larger in the control group than in the experimental group. Significant differences were found in these measurements, which differed from the result obtained by Hassan [30], who found uniformity between results.

Regarding the branch width, the experimental group showed a slightly wider measurement than the control group did. This result was in line with Hassan's study [30], although Hassan's results showed a sharper difference.

In our study, the measurements of the length of the mandibular body were uniform for both groups; therefore, there were no statistically significant differences.

This result was in agreement with the the results of the studies of Kaplan [32] and Djerkes [6], in which the values of this measurement were statistically insignificant; however, in contrast to the studies of Hassan [30] and Capelli [5], the length of the mandibular body was larger in the control group.

According to the results of our study, the sigmoid notch was deeper in the experimental group than in the control group ($p < 0.030$), and this may be related to the greater size of the bony structures of the mandible. In fact, this corresponded to the results obtained through the measurements of the length of the condyle and coronoid process, which were longer in the experimental group than in the control group.

This result contrasts with that of Yamaki's study [1], which showed higher measurements for the control group than the experimental group in relation to the depth of the sigmoid notch. This may have been due to the use of a different measurement technique or a different sampling method.

It should be noted, however, that the depth of the notch of the anterior and posterior branches in our study showed no relevant differences, as the posterior depth was greater in the experimental group, but the anterior depth was greater in the control group.

Regarding the retromolar space, our study found a significant difference between the two groups: the control group reported a mean measurement of 1.52 cm, which was significantly higher than the space in the experimental group, which was 1.14 cm, on average ($p < 0.001$). This result is in line with the results of the studies carried out by Hattab [31] in Jordan (a measurement of 1.44 cm for the control group and of 1.10 cm for the experimental group was found) and by Qamruddin [34] in Pakistan (a measurement of 1.63 cm for the control group and 1.12 cm for the experimental group was found).

According to Uthman [27], the retromolar space measurable from orthopanoramic radiographs should be more than 12 mm. This figure corresponded to the measurements in our study.

Regarding the the space-witdth ratio of the lower third molar, the results that we obtained show that the control group had a ratio of 1.09 and that the experimental group had a ratio of 0.81. These ratios were very similar to those found by the studies already mentioned by Hattab [31] and Al-Gunaid [1].

In the angular measurements, however, the gonial angle was wider in the control group than in the experimental group. This result agreed with the results of the previous studies by Ganss [8] and Richardson [22]; however, they contrasted with those of Hattab [31] and Al-Gunaid [1], who found a wider angle for the experimental group than for the control group.

Finally, Behbehani [4] stated that a smaller gonial angle may be associated with an increased risk of lower third molar inclusion [10,27,35,36]. This was in agreement with our results.

In our study, the angulation of the lower posterior teeth, specifically the first and second molars, was greater in the experimental group. The control group showed a smaller angle and a more upright position. This result aligned with previous studies that have concluded that the inclination of the posterior teeth is a possible cause of the inclusion of lower third molars.

On the other hand, it should be noted that, in our study, the inclination of the lower third molars was greater in the experimental group than it was in the control group, and this difference was highly significant ($p < 0.002$).

This result agreed with the results of previous studies by Ricketts [37], Hassan [30], Capelli [5] and Hugoson [38] and confirmed that the angle of a lower third molar, in relation to mandibular pain, can be an index for predicting tooth inclusion.

To investigate whether there are any gender differences in mandibular geometry related to third molar impaction, the sample was divided into males and females. The impaction groups (FB and MB) were compared with their respective control groups.

Most of the differences between the control groups and the experimental groups were found among males; the male control group showed a larger retromolar space and retromolar area to the third molar ratio than the male experimental group did. This result agreed with the results of previous studies by Hassan [30]

Their results also disagree with those of Kaplan [32], who found no significant sex predilection when comparing the experimental group to the control group. The variation influenced by sex gender observed in different studies appears to be linked to the variability in the timing of mandibular skeletal maturity between males and females. This could be attributed to the continued growth of the mandible in males until the age at which third molars are about to erupt.

5. Conclusions

By evaluating the relevant data present in the existing literature, through accurate and simple data analysis, our observational cross-sectional study has found an associative link between some of the investigated variables in the conformation of the mandible associated with the impaction of third molars, in accordance with some of the literature.

Such a study requires further investigation with experimental studies (randomized clinical trials). In this way, it will be possible to identify and confirm the predictive factors in the impaction of mandibular third molars in relation to mandibular dimensions.

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References

1. Al-Gunaid, T.H.; Bukhari, A.K.; El Khateeb, S.M.; Yamaki, M. Relationship of Mandibular Ramus Dimensions to Lower Third Molar Impaction. *Eur. J. Dent.* **2019**, *13*, 213–221. [CrossRef] [PubMed]
2. Al-Zoubi, H.; Alharbi, A.A.; Ferguson, D.J.; Zafar, M.S. Frequency of impacted teeth and categorization of impacted canines: A retrospective radiographic study using orthopantomograms. *Eur. J. Dent.* **2017**, *11*, 117–121. [CrossRef] [PubMed]
3. Andreasen, J.O. Epidemiology of third molar impaction. In *Textbook and Color Atlas of Tooth Impactions*; Andreasen, J.O., Peterson, J.K., Laskin, D.M., Eds.; Munksgaard: Copenhagen, Denmark, 1997; pp. 222–223.
4. Behbehani, F.; Årtun, J.; Thalib, L. Prediction of mandibular third-molar impaction in adolescent orthodontic patients. *Am. J. Orthod. Dentofac. Orthop.* **2006**, *130*, 47–55. [CrossRef] [PubMed]
5. Capelli, J., Jr. Mandibular growth and third molar impaction in extraction cases. *Angle Orthod.* **1991**, *61*, 223–229. [PubMed]
6. Dierkes, D.D. An investigation of the mandibular third molars in orthodontic cases. *Angle Orthod.* **1975**, *45*, 207–212.
7. Forsberg, C.M.; Vingren, B.; Wesslén, U. Mandibular third molar eruption in relation to available space as assessed on lateral cephalograms. *Swed. Dent. J.* **1989**, *13*, 23–31.
8. Ganss, C.; Hochban, W.; Kielbassa, A.M.; Umstadt, H.E. Prognosis of third molar eruption. *Oral Surg. Oral Med. Oral Pathol.* **1993**, *76*, 688–693. [CrossRef]
9. Gonca, M.; Gunacar, D.N.; Kose, T.E.; Karamehmetoglu, I. Evaluation of mandibular morphologic measurements and trabecular structure among subgroups of impacted mandibular third molars. *Oral Radiol.* **2021**, *38*, 63–71. [CrossRef]
10. Vaibhav, N.; Vivek, G.; Shetty, A.; Mohammad, I.; Ahmed, N.; Umeshappa, H. Efficacy of various routes of dexamethasone administration in reducing postoperative sequelae following impacted third molar surgery. *Ann. Maxillofac. Surg.* **2020**, *10*, 61–65. [CrossRef]

11. Garcia, R.I.; Chauncey, H.H. The eruption of third molarsin adults: A 10-year longitudinal study. *Oral Surg. Oral Med. Oral Pathol.* **1989**, *68*, 9–13. [CrossRef]
12. Ghaeminia, H.; Nienhuijs, M.E.; Toedtling, V.; Perry, J.; Tummers, M.; Hoppenreijs, T.J.; Van der Sanden, W.J.; Mettes, T.G. Interventions for treating trouble-free impacted wisdom teeth in adults. *Cochrane Database Syst Rev.* **2020**, *5*, CD003879. [CrossRef]
13. Mettes, T.D.; Ghaeminia, H.; Nienhuijs, M.E.; Perry, J.; van der Sanden, W.J.; Plasschaert, A. Surgical removal versus retention for the management of asymptomatic impacted wisdom teeth. *Cochrane Database Syst Rev.* **2012**, *13*, CD003879. [CrossRef]
14. Jeevitha, J.Y.; Thiagarajan, A.; Sivalingam, B. Influence and Impact of Mandibular Ramal Dimensions on the Incidence of Lower Third Molar Impaction: A Prospective Study. *J. Pharm. Bioallied Sci.* **2022**, *14* (Suppl. 1), S364–S368. [CrossRef]
15. Bodner, L.; Brennan, P.A.; McLeod, N.M. Characteristics of iatrogenic mandibular fractures associated with tooth removal: Review and analysis of 189 cases. *Br. J. Oral Maxillofac. Surg.* **2011**, *49*, 567–572. [CrossRef]
16. Boffano, P.; Roccia, F.; Gallesio, C.; Berrone, S. Pathological mandibular fractures: A review of the literature of the last two decades. *Dent. Traumatol.* **2013**, *29*, 185–196. [CrossRef]
17. Memè, L.; Strappa, E.M.; Monterubbianesi, R.; Bambini, F.; Mummolo, S. SEM and FT-MIR Analysis of Human Demineralized Dentin Matrix: An In Vitro Study. *Appl. Sci.* **2022**, *12*, 1480. [CrossRef]
18. Rossi, R.; Modoni, M.; Monterubbianesi, R.; Dallari, G.; Memè, L. The 'Guided Tissue Regeneration (GTR) Effect' of Guided Bone Regeneration (GBR) with the Use of Bone Lamina: A Report of Three Cases with More than 36 Months of Follow-Up. *Appl. Sci.* **2022**, *12*, 11247. [CrossRef]
19. Rossi, R.; Memè, L.; Strappa, E.M.; Bambini, F. Restoration of Severe Bone and Soft Tissue Atrophy by Means of a Xenogenic Bone Sheet (Flex Cortical Sheet): A Case Report. *Appl. Sci.* **2023**, *13*, 692. [CrossRef]
20. Grassi, A.; Memè, L.; Strappa, E.M.; Martini, E.; Bambini, F. Modified Periosteal Inhibition (MPI) Technique for Extraction Sockets: A Case Series Report. *Appl. Sci.* **2022**, *12*, 12292. [CrossRef]
21. Khalil, H. Skeletal tracing of impacted and erupted mandibular third molar areas using panoramic radiographs. *Biosci. Biotechnol. Res. Asia* **2016**, *7*, 1–6.
22. Richardson, M.E. The etiology and prediction of mandibular third molar impaction. *Angle Orthod.* **1977**, *47*, 165–172. [PubMed]
23. Chen, Y.W.; Lee, C.T.; Hum, L.; Chuang, S.K. Effect of flap design on periodontal healing after impacted third molar extraction: A systematic review and meta-analysis. *Int. J. Oral. Maxillofac. Surg.* **2017**, *46*, 363–372. [CrossRef] [PubMed]
24. Trakiniene, G.; Šidlauskas, A.; Švalkauskienė, V.; Smailienė, D.; Urbonė, J. The magnification in the lower third and second molar region in the digital panoramic radiographs. *J. Forensic. Dent. Sci.* **2017**, *9*, 91–95. [CrossRef]
25. Caymaz, M.G.; Buhara, O. Association of Oral Hygiene and Periodontal Health with Third Molar Pericoronitis: A Cross-Sectional Study. *Biomed. Res. Int.* **2021**, *2021*, 6664434. [CrossRef]
26. Ongkosuwito, E.M.; Dieleman, M.M.; Kuijpers-Jagtman, A.M.; Mulder, P.G.; van Neck, J.W. Linear mandibular measurements: Comparison between orthopantomograms and lateral cephalograms. *Cleft Palate Craniofac. J.* **2009**, *46*, 147–153. [CrossRef]
27. Uthman, A.T. Retromolar space analysis in relation to selected linear and angular measurements for an Iraqi sample. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endodontol.* **2007**, *104*, e76–e82. [CrossRef]
28. Gupta, S.; Jain, S. Orthopantomographic Analysis for Assessment of Mandibular Asymmetry. *J. Indian Orthod. Soc.* **2012**, *46*, 33–37. [CrossRef]
29. Haralabakis, H. Observations on the time of eruption, congenital absence and impaction of the third molar teeth. *Trans. Eur. Orthod. Soc.* **1957**, *33*, 308–309.
30. Hassan, A.H. Mandibular cephalometric characteristic of a Saudi sample of patients having impacted third molars. *Saudi Dent. J.* **2011**, *23*, 73–80. [CrossRef]
31. Hattab, F.N.; Alhaija, E.S. Radiographic evaluation of mandibular third molar eruption space. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod.* **1999**, *88*, 285–291. [CrossRef]
32. Kaplan, R.G. Some factors related to mandibular third molar impaction. *Angle Orthod.* **1975**, *45*, 153–158. [PubMed]
33. Niedzielska, I.A.; Drugacz, J.; Kus', N.; Kręska, J. Panoramic radiographic predictors of mandibular third molar eruption. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endodontol.* **2006**, *102*, 154–158. [CrossRef]
34. Qamruddin, I.; Qayyum, W.; Haider, S.M.; Siddiqui, S.W.; Rehan, F. Differences in various measurements on panoramic radiograph among erupted and impacted lower third molar groups. *J. Pak. Med. Assoc.* **2012**, *62*, 883–887.
35. Shiller, W.R. Positional changes in mesio-angular impacted mandibular third molars during a year. *J. Am. Dent. Assoc.* **1979**, *99*, 460–464. [CrossRef]
36. Ventä, I.; Murtomaa, H.; Turtola, L.; Meurman, J.; Ylipaavalniemi, P. Clinical follow-up study of third molar eruption from ages 20 to 26 years. *Oral Surg. Oral Med. Oral Pathol.* **1991**, *72*, 150–153. [CrossRef]
37. Ricketts, R.M. A principle of arcial growth of the mandible. *Angle Orthod.* **1972**, *42*, 368–386.
38. Hugoson, A.; Kugelberg, C.F. The prevalence of third molars in a Swedish population. An epidemiological study. *Community Dent. Health* **1988**, *5*, 121–138.