Factors associated with mandibular third molar eruption and impaction

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A retrospective study, using panoramic radiographs, was conducted on 152 Taiwanese (72 males and 80 females) to investigate mandibular third molar eruption and impaction. The following measurements were made: inclinations and mesiodistal crown widths of the mandibular molars, vertical and horizontal spaces between the distal surface of the second molar and the anterior surface of the ramus, lengths and widths of the mandibular ramus and body, the ramus inclination, the mandibular plane angle, and the mandibular gonial angle. Differences between non-impaction and impaction groups were studied, and the variables were analyzed with multivariate discriminatory analysis. Significant differences between the two groups were found; variables describing spaces between the anterior of the ramus and the distal of the mandibular second molar and tooth size appeared to be the primary contributors to the differences observed.

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INTRODUCTION

The development of third molars and their influence on the dental arches has long been of concern to the dental profession.[1,2] Third molars are the most-common teeth that may follow an abortive eruption path and become impacted.[3,4] The incomplete eruption of third molars remains a serious problem in dentistry,[5] primarily because of its high incidence and clinical consequences. Impaction of the mandibular third molar is a complex multifactorial mechanism. Even in the absence of clinical symptoms, impacted third molars may be associated with various pathological processes ranging from simple caries and pericoronitis to cysts and neoplastic lesions.[6]

It has been estimated that 54% of mandibular third molars are removed prophylactically in the absence of any subjective symptoms.[7] Previous findings revealed that third molars undergo continuous clinical change up to at least the age of 32 years.[8] Besides, horizontally impacted third molars, a substantial proportion of other impaction types, do erupt fully, and radiographically apparent impaction in late adolescence should not set sufficient grounds for their prophylactic removal in the absence of other clinical indications.[9] Retaining non-impacted mandibular third molars might be beneficial for both orthodontic and prosthodontic treatment as well as possible transplantation.[10]

The aim of this investigation was to identify a model of panoramic variables for diagnosis of lower permanent third molar impaction. In order to determine if any significant differences existed between persons having permanent dentition with an impacted mandibular third molar and persons having permanent dentition with a non-impacted mandibular third molar, discriminant analysis was performed to identify the key determinants for discriminating between the two groups.

MATERIALS AND METHODS

Standard panoramic radiographs were used in this study. Seventy-two male and eighty female Taiwanese subjects, ranging in age from 20 to 25 years, were selected for the study. All panoramic radiographs were of good quality. All subjects had untreated occlusions with a full complement of permanent teeth. A group of subjects (30 males and 44 females) who had non-impacted mandibular third molars on both sides was compared with a group of subjects (42 males and 36 females) who had horizontally impacted mandibular third molars on both sides.

The radiographs were traced on overlying matte acetate paper using an X-ray viewer. Eighteen reference points on the tracings (Figure 1) were digitized using an image analyzer, converted to an X-Y coordinate system and input into a personal computer. Sixteen measurements were calculated using these points.

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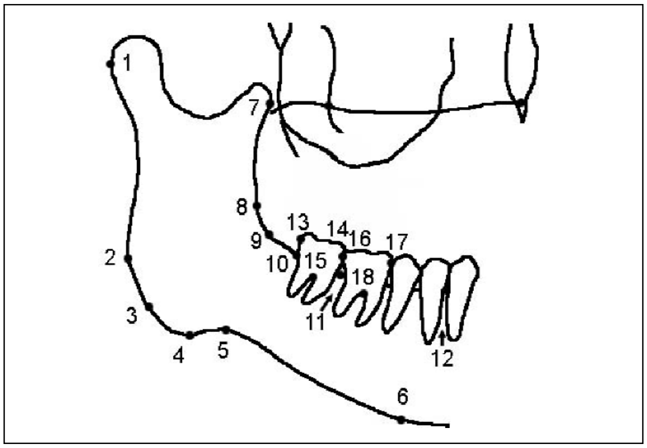

Figure 1. Reference Points
1: the point on the condyle head in contact with and tangent to the ramus plane
2: the point on the mandibular angle in contact with and tangent to the ramus plane
3: the exterior turning point of the ramus and the mandibular body
4: the point on the mandibular angle in contact with and tangent to the mandibular plane
5: the deepest point on the antegonial notch
6: the point on the inferior mandibular border in contact with and tangent to the mandibular plane
7: the most superior anterior convex point on the coronoid process
8: the most inferior concave point on the anterior border of the ramus
9: the internal turning point of the ramus and the mandibular body
10: the point of intersection of the anterior ramus border and the distal surface of the second molar
11: the most superior point on the alveolar crest between the first molar and the second molar
12: the most superior point on the alveolar crest between the canine and the first premolar
13: the most distal convex point on the crown of the second molar
14: the most mesial convex point on the crown of the second molar
15: the furcation point on the root of the second molar
16: the most distal convex point on the crown of the first molar
17: the most mesial convex point on the crown of the first molar
18: the furcation point on the root of the first molar

(Figure 2). The straight line that passes anterior to the nasal spine and the point on the medial wall of the maxillary sinus that intersects with the hard palate was designated the X-axis. The straight line vertical to the X-axis and passing through the ANS at a right angle was designated the Y-axis. The X coordinate value of each reference point was considered the horizontal position of the structure. The Y coordinate value of each reference point was considered the vertical position of the structure.

All statistical analyses were performed using the Microsoft Excel statistical software package. Mean values of the X and Y coordinate values of all reference points and mean values and standard deviations for all measurements were calculated for both groups and for the left and right sides separately. Statistical comparisons of the two groups were performed with Student's *t*-test. To build a model of impacted and non-impacted groups, multivariate discriminant analyses were carried out. The 5% level of significance ($p < 0.05$) was used.

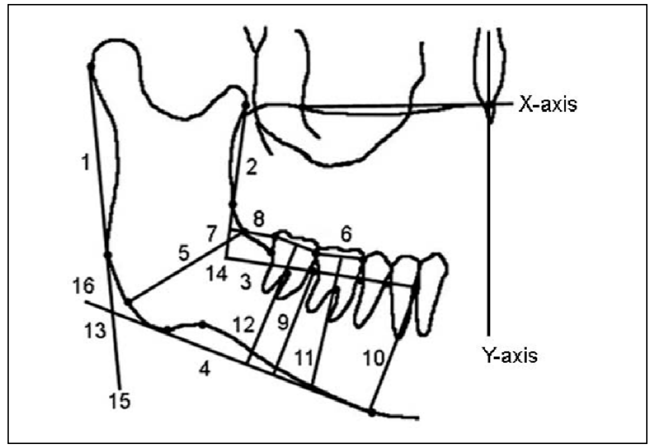

Figure 2. Measurements
1 (ramus height-P): the distance between reference points 1 and 2
2 (ramus height-A): the distance between reference points 7 and 8
3 (body length-U): the distance between reference points 12 and the intersection of line 7-8 (reference point 7 to 8) and line 11-12 (reference point 11 to 12)
4 (body length-L): the distance between reference points 5 and 6
5 (ramus width): the distance between reference points 3 and 9
6 (first molar width): the distance between reference points 16 and 17
7 (space-V): the distance of perpendicular line from reference point 13 to line 7-8 (reference point 7 to 8)
8 (space-H): the distance between the intersection of line 7-8 (reference point 7 to 8) to line 11-12 (reference point 11 to 12) and the intersection of perpendicular line from reference point 13 to line 7-8 (reference point 7 to 8)
9 (body width-P): the distance of perpendicular line from point 11 to line 4-6 (reference point 4 to 6)
10 (body width-A): the distance of perpendicular line from point 12 to line 4-6 (reference point 4 to 6)
11 (first molar inclination): the angle of first molar axis (mid point of reference points 16 and 17 to reference point 18) and line 4-6 (reference point 4 to 6)
12 (second molar inclination): the angle of second molar axis (mid point of reference points 13 and 14 to reference point 15) and line 4-6 (reference point 4 to 6)
13 (gonial angle-O): the angle of line 1-2 (reference point 1 to 2) and line 4-6 (reference point 4 to 6)
14 (gonial angle-I): the angle of line 7-8 (reference point 7 to 8) and line 11-12 (reference point 11 to 12)
15 (ramus plane angle): the angle of line 1-2 (reference point 1 to 2) and X-axis
16 (mandibular plane angle): the angle of line 4-6 (reference point 4 to 6) and X-axis

RESULTS

Because no significant differences were noted between the right and left mean values for both genders, results of the comparison only on the right side are shown. Tables 1 and 2 show the mean values and standard deviations of each measurement and the results of Student's *t*-tests for males and females, respectively. There were statistically significant differences between the two groups in mesiodistal crown widths of the first mandibular molar and spaces between the distal surface of the second molar and the anterior border of the ramus, for both genders.

Discriminant analysis was performed using seven variables for males and six variables for females, and significant difference between groups were exhibited. Table 3 represents Fisher's linear discriminant function

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Table 1. Mean values and standard deviations of measurements and results of Student's t-tests (male)

	Impacted (N=42)		Non-impacted (N=30)		Students
Measurements	Mean	SD	Mean	SD	t-test
ramus height-P	33.54	8.01	30.78	3.57	P = 0.082
ramus height-A	13.33	3.34	12.83	1.78	P = 0.456
body length-U	29.54	6.42	28.95	3.58	P = 0.651
body length-L	30.09	7.56	25.55	5.09	P = 0.006
ramus width	23.53	6.11	20.34	3.23	P = 0.011
first molar width	8.41	1.60	7.45	0.81	P = 0.004
space-H	4.37	1.97	6.20	1.86	P < 0.001
body width-P	7.36	4.47	7.67	3.12	P = 0.740
body width-A	19.67	5.89	19.79	2.74	P = 0.918
space-V	3.29	1.62	4.70	1.33	P < 0.001
first molar inclination	83.37	6.66	78.78	5.19	P = 0.002
second molar inclination	84.49	7.79	83.51	6.67	P = 0.579
gonial angle-O	118.75	7.91	121.10	7.80	P = 0.215
gonial angle-I	94.19	4.16	87.97	5.11	P < 0.001
ramus plane angle	87.95	7.71	85.24	6.09	P = 0.114
mandibular plane angle	26.69	6.56	26.33	6.67	P = 0.822

Table 2. Mean values and standard deviations of measurements and results of Student's t-tests (female)

	Impacted (N=36)		Non-impacted (N=44)		Students
Measurements	Mean	SD	Mean	SD	t-test
ramus height-P	28.25	4.40	28.72	2.59	P = 0.558
ramus height-A	11.89	1.92	10.70	1.83	P = 0.006
body length-U	27.09	2.20	26.97	2.67	P = 0.827
body length-L	24.27	4.02	26.18	5.03	P = 0.070
ramus width	20.50	2.80	20.18	2.47	P = 0.591
first molar width	7.58	0.61	7.21	0.80	P = 0.027
space-H P < 0.001		3.88	1.54	5.34	1.07
body width-P	7.92	2.47	6.98	6.94	P = 0.443
body width-A	20.04	2.27	17.23	4.73	P = 0.002
space-V P < 0.001		2.79	1.36	3.78	0.91
first molar inclination	83.31	7.65	84.04	6.62	P = 0.647
second molar inclination	84.78	6.68	90.36	8.37	P = 0.002
gonial angle-O	120.46	9.47	120.60	6.79	P = 0.941
gonial angle-I	91.69	6.29	93.97	10.09	P = 0.241
ramus plane angle	88.16	9.82	87.31	6.02	P = 0.633
mandibular plane angle	28.63	6.42	27.91	6.31	P = 0.615

coefficients of the variables and constants and the classification results of the discriminant analysis. According to the results using the above-described variables, 90.1% and 82.3% of the original grouped cases were correctly classified for males and females, respectively.

Figures 3 and 4 show the superimpositions of the mean positions of the reference points in the two groups for males and females, respectively. Positions of each tooth are shown by triangles, while positions of

Table 3. Fisher's Linear Discriminant Functions Coefficients and Classification Results of Discriminant Analysis

Female	
Discriminating variables	**Coefficients**
ramus height-A	-0.2249
first molar width	0.3667
space-H	0.6938
body width-A	-0.2772
space-V	0.7769
second molar inclination	-0.0812
Constant	-7.8888
F-value	9.6211913
P-value	<0.001
Mahalanobis' generalized distance	3.1506087
Classification Results-correctly classified	82.3%
Male	
Discriminating variables	**Coefficients**
body length-L	-0.0868
ramus width	0.1116
first molar width	-1.1096
space-H	0.5865
space-V	-0.0418
first molar inclination	0.0129
gonial angle-I	-0.3313
Constant	-22.6199
F-value	9.543382005
P-value	<0.001
Mahalanobis' generalized distance	4.26500898
Classification Results-correctly classified	90.1%

the mandibular ramus and body are shown by lines that connect the reference points.

DISCUSSION

A panoramic radiograph gives as reliable a measurement of the gonial angle as does a lateral cephalometric radiograph and gives a clear picture of the mandibular molars without superimposition. The results in this study for the left and right sides were analyzed separately but were combined for the tables and figures because there were no statistical differences between left and right side values.

The incidence of mandibular third molar impaction varies considerably among different populations. In addition to racial variances, other factors influencing the incidence of third molar impaction are the nature of the diet, the degree of use of the masticatory apparatus, the extent of generalized tooth attrition, and genetic inheritance. Third molar impaction may be caused by inadequate space, limited skeletal growth, distal eruption of the dentition, vertical direction of condylar growth, increased crown size of impacted teeth, and the late maturation of the third molars. Some structures, such as the buccinator muscle, pterygomandibular raphe, or external oblique ridge, may also be factors in third molar impaction.

Previous studies showed that the eruption or

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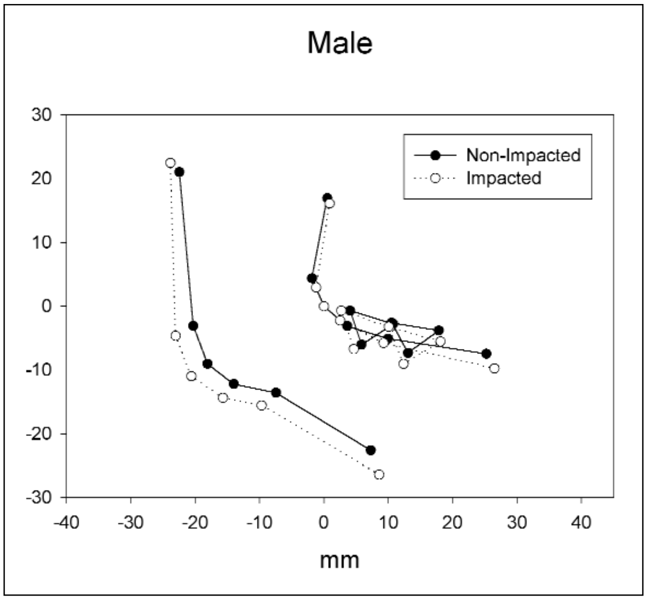

Figure 3.
Superimpositions of the mean positions of the reference points

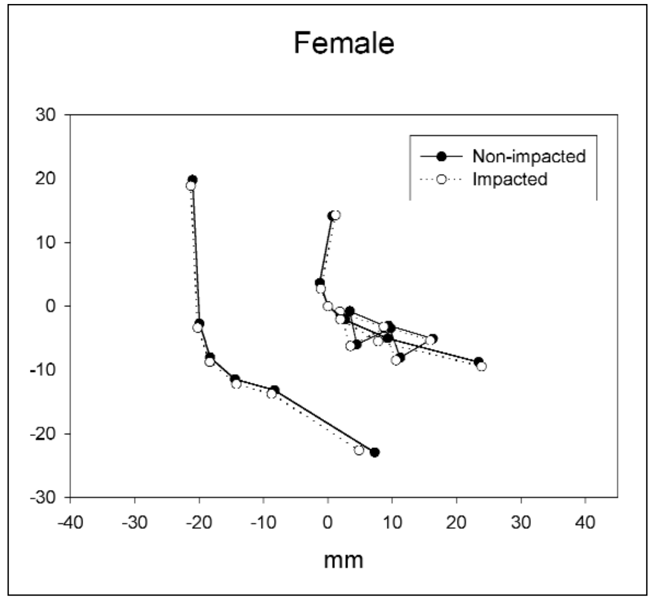

Figure 4.
Superimpositions of the mean positions of the reference points

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impaction of mandibular third molars is related to genetic factors,[11] and has even been attributed to consequences of eating habits in civilized humans.[12] But facial growth and development were proven to be directly associated with the position of mandibular third molars.[13] However, another study[14] indicated no correlation between mandibular length and impaction or eruption of the mandibular third molars. This study agrees with the previous reports,[15-17] concerning the association of impacted mandibular third molars with inadequate space between the anterior of the ramus and the distal of the mandibular second molar. In addition to that space, in this study another factor related to mandibular third molar impaction was found: the mesiodistal crown dimension of the mandibular first molar, which was larger in the impacted group than in the non-impacted group.

The development of the mandibular third molar may begin between the ages of 7 and 14 years with the peak formation period at 8~9 years.[18] The mandibular third molar develops in the ramus of the mandible; its occlusal surface faces upwards and forwards, and as space becomes available for it by growth of the mandible, it rotates into a more upright position. Therefore, space for third molar eruption is made partially by the forward movement of the dentition and partially by the resorption of bone at the back of the dental arch. The pattern of growth that influences this space should be considered. Mandibular growth takes place as cartilaginous growth at the condyle, as appositional growth on the posterior surface of the ramus, and as remodeling of the anterior border of the ramus. The overall result of these patterns is a downward and forward movement of the mandibular body with posterior movement of the ramus. The anteroposterior dimension of the retromolar spaces is increased, and therefore, the permanent molars are accommodated as a result of the posterior retreat of the ramus. Mandibular growth is responsible for increasing the retromolar space and may continue, to some degree, into young adulthood. Forward movement of the mandibular posterior teeth from either interproximal wear, anterior component of forces or from crowding of the incisor

Table 4. Fisher's Linear Discriminant Functions Coefficients and Classification Results of Discriminant Analysis

Female	
Discriminating variables	**Coefficients**
ramus height-P	0.0858
body length-L	0.2071
first molar width	-0.8314
gonial angle-O	0.0079
ramus width	-0.1629
Constant	2.2433
F-value	2.8827702
P-value	0.0198
Mahalanobis' generalized distance	0.7758969
Classification Results-correctly classified	67.1%
Male	
Discriminating variables	**Coefficients**
ramus height-P	0.1488
body length-L	-0.0998
first molar width	-0.5773
gonial angle-O	0.0473
ramus width	-0.0985
Constant	1.8961
F-value	2.7881552
P-value	0.0242
Mahalanobis' generalized distance	0.8626483
Classification Results-correctly classified	74.6%

segment may result in an increase in the space of the retromolar region after adulthood.

Figures 3 and 4 in this study show that a larger ramus width also seems to be indicative of third molar impaction. In order to determine to what extent the morphological characteristics may be related to mandibular third molar impaction, another discriminant analysis using variables that represent the morphology of the mandible and first molar was carried out (Table 4). The results showed that 74.6% and 67.1% of the original grouped cases were correctly classified for males and females, respectively. This suggests that although the morphological characteristics may somewhat affect mandibular third molar eruption or impaction, mandibular third molar impaction might not be a purely local morphological occurrence and may be the local manifestation of a general condition. There are still many unanswered questions about mandibular third molar eruption and impaction. Further investigations are needed to find predicting factors for mandibular third molar impaction.

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Recent trends in Child restraint practices in the United States

Winston LK, Chen IG, Elliott MR, Arbogast KB,
Durbin DR.
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www.pediatrics.org/cgi/content/full113/5/e458

This study assessed the trends in restraint types used by children under the age of 9 years.

A study was made using data collected from insurance claims from 15 states in the US from December 1998 to November 2002. The data represented 128,000 crashes involving close to 150,000 children. Parent report was used to determine the type of restraint used at the time of the crashes.

If overall seat belt use decreased significantly from 49% to 36%, the use of child restraints increased from 49% to 63% from 1998 to 2002.

For 7 to 8 years old it increased from 2% to 5 %. For 3 to 5 years of age from 35% to 65% and for children from birth to 2 years from 97% in 1997 to 98% in 2002.

Even if significant achievements have been made in issues concerning passenger car safety (see J.Clin.Ped.Dent.30:8, 2005), 62% of children between 4 to 8 years remain inadequately restrained to adult seat belts. Sustained efforts must be maintained in this field.

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