Predicting Angulational Development and Eruption of the Lower Third Molar

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Every orthodontist knows that in planning a course of treatment the third molar teeth, and especially lowers, must be taken into consideration. The main points to be decided are whether these teeth will erupt or become impacted, whether they will cause crowding of the arch and whether the extraction of some other teeth will prevent crowding and influence the eruption of third molars.

In cases with insufficient space and/or with unfavourable angulation of the third molar the tooth will be impacted. Meade[15] and Dachi and Howell[6] report that 18.8 and 16.7 percent, respectively, of their material showed at least one impacted tooth and in about 80 percent the impacted teeth were third molars. Haralabakis[9] quoted a prevalence of 17.5 percent of third molar impactions. Aitasalo et al.[1] found impacted third molars in 10.5 percent. Silling[20] in a sample of 100 orthodontic patients without extractions reported that 67 percent of males and 69 percent of females developed impacted third molars. Morris and Jerman[17] found the percentage of impacted third molars to be 65 in USAF recruits. Hellman[10] in a study of 261 male and 172 female students found that 9.51 percent of the males and 20.8 percent of the females had one or more impacted third molars. He showed that the students with impacted third molars were lighter in weight and had smaller cranial dimensions than those without impactions. He concluded that the M_3 impaction may not be a purely local occurrence but rather a local manifestation of a general condition. Björk et al.[3] reported every fourth or fifth Scandinavian adult male had an impacted third molar. They established an association between impaction and lack of space for the lower third molar; the lack of space was correlated with three skeletal factors: vertical direction of the condylar growth, short mandibular length, and a backward-directed eruption of the dentition. A fourth factor which contributed to third molar impaction was retarded maturation of the tooth. Broadbent[4] described the development of the mandibular third molars and reported on the relationship of their impaction to retarded facial development. There is general agreement among Hellman, Björk and Broadbent that the impaction of third molars is closely related to insufficient growth of the jaws.

Faubion[8] states that premolar extractions help to provide space for the eruption of mandibular third molars. McCoy[16] strongly opposed this concept, drawing on many years of clinical experience that premolar extractions have very little effect in preventing third molar impactions. McBride and Huggins[13] found the extraction of second molars to be favourable to the eruption of third molars. Cryer[5] reported that, in 66 orthodontic cases in which lower second molars were extracted, 56 percent of the lower third molars erupted in good position.

Kaplan[11] studied a postretention group of 75 orthodontically treated patients an average of 9.3 years after the retention. His data indicated that the

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TABLE I
The number of subjects and teeth, mean age at initial and follow-up examinations, and the follow-up time.

	No. of subjects	teeth	Age in years initially $\bar{x}$	SD	follow-up $\bar{x}$	SD	Follow-up time, years $\bar{x}$	SD	No. of teeth at end
Normal	80	156	13.8	2.2	19.7	2.7	5.8	2.4	152
Extraction	30	60	13.1	1.5	19.1	2.2	5.9	1.9	57

presence of the lower M_3 did not appear to produce a greater degree of lower anterior crowding and rotational relapse after the cessation of retention than that which occurs in patients with M_3 agenesis.

Aitasalo et al.[2] reported that the most frequent angulation of the impacted third molars in their material was vertical. Morris and Jerman[17] noted the mesioangular position to be most common (42%) followed by the vertical position (40.7%). Richardson[18] states that in the early stages of calcification the lower third molar is tilted mesially forming an angle with the mandibular plane of 38 degrees.

Material and Method

The material consisted of a longitudinal set of orthopantomograms of 110 young people. In 80 of the cases they were randomly selected from a larger set of orthopantomograms of normal healthy children, the only criteria being that the children had all their teeth and that the development of the lower third molars was at about the stage of crown completion. The latter criterion was used in selecting 30 orthodontic patients with two lower premolar extractions. These two groups of subjects had second orthopantomograms made about 6 years after the first.

The first was taken at an average age of 13.5 years at approximately the stage of crown completion, and the second at approximately 19.5 years when the wisdom tooth could be expected to have developed and possibly erupted. In the event of a clinical eruption it was recorded at the second visit. The material is presented in Table I.

The following angles and planes were drawn and measured from the 220 orthopantomograms with 0.5° and 0.5 mm accuracy (Fig. 1): 1) mandibular plane, tangent through the two lowest points on the border of the mandible; 2) ramus plane, tangent through the two most distal points of the ramus; 3) longitudinal axes were drawn to M_3 and M_2 teeth through the occlusal middle point and the bifurcation point of the roots; 4) the space between M_2 and M_3 molars was measured as the shortest distance between the distal surface of the second molar and the adjacent surface of the third molar. α = gonial angle, between the mandibular plane and the ramus plane; β = angulation of M_3 to M_2 tooth; γ = angulation of M_2 to the mandibular plane.

The size and changes, if any, in the above angles were studied individually, and the mean values for the two groups calculated. The intercorrelation of the

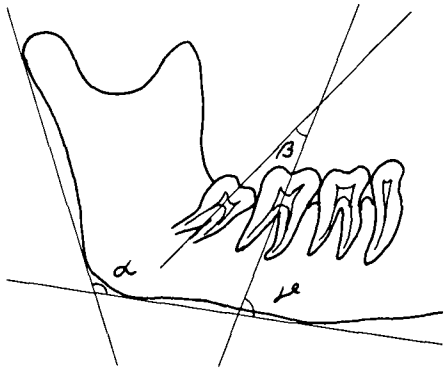
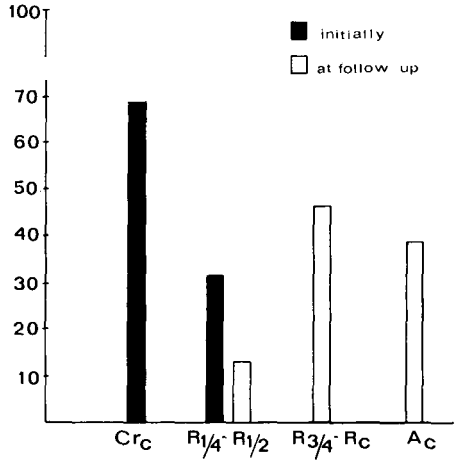
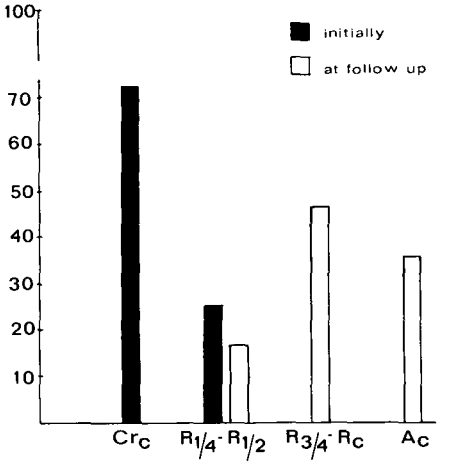


Fig. 1 The lines and angles used in this study.



Normal group

Fig. 2 The percentage of the lower third molars in the different stages of development initially and at follow-up. Normal group.



Extraction group

Fig. 3 The percentage of the lower third molars in the different stages of development initially and at follow-up. Extraction group.

angles was analysed, as was the magnitude of influence of each of these three angles on the eruption of the M_3 tooth. Regression and correlation analyses were used.

The aims of this study were to discover whether there are any early symptoms that could be used as prognostic criteria of the development and the eruption of the lower wisdom teeth and to study the effect of lower premolar extractions on the development and eruption of M_3.

Results

The results are given in Figures 2, 3, 4 and 5 and in Tables II-IX.

Figures 2 and 3 show that the completed crown stage was dominant in about 70 percent of the normal and the extraction groups, and the remaining 30 percent of the teeth had reached the ¼ root stage. At end of the study 47 percent of the teeth had reached the stage of ¾ or of complete root development and almost 40 percent had their apices closed.

At the first examination the shortest distance between the crowns of M_3 and M_2 teeth in the normal group was 0 mm in 69 percent of the cases. In the extraction patients the same distance was found in 72 percent. In the remaining cases the mean value was

TABLE II

The prevalence of mesial, distal and parallel angulations and the number of of extractions and erupted teeth, as percentages.

	Initially				
	mesial	parallel	distal	erupted	extracted
Normal	99.4	0.6	—	—	—
Extraction	98.3	1.7	—	—	—
	Follow-up				
	mesial	parallel	distal	erupted	extracted
Normal	77.3	7.8	15.6	28.2*	3.8
Extraction	71.9	5.3	22.8	35.0*	1.8

* The difference between the two groups was NS.

TABLE III

Normal group: Distribution of initial angulations (β) and their developmental changes in M_3

Initial angulation	No. of teeth	(%)	Percentage of teeth in the different follow-up angulations. distal	parallel	0.5-10°	∠20°	∠30°	∠40°	∠50°	50°∠
distal	—									
parallel	2	(1.3)	—	100.0	—	—	—	—	—	—
0.5-10°	10	(6.6)	20.0	60.0	—	20.0	—	—	—	—
11.20°	48	(31.7)	4.2	16.7	16.7	33.3	18.8	8.3	—	2.0
21-30°	60	(39.5)	6.7	8.3	16.7	33.3	21.6	6.7	5.0	1.7
31-40°	29	(19.0)	3.5	13.8	20.7	17.2	27.6	6.9	10.3	—
41-50°	3	(1.9)	—	—	33.3	33.3	—	33.3	—	—
Total	152	(100.0)	6.0	16.5	15.8	29.6	19.7	7.2	3.9	1.3

TABLE IV

Extraction group: Distribution of initial angulations (β) and their developmental changes in M_3.

Initial angulation	No. of teeth	(%)	Percentage of teeth in the different follow-up angulations distal	parallel	0.5-10°	∠20°	∠30°	∠40°	∠50°	50°∠
distal										
parallel	1	(1.8)	—	—	—	—	—	—	100.0	—
0.5-10°	2	(3.5)	—	—	—	50.0	50.0	—	—	—
11-20°	19	(33.3)	5.3	26.3	15.8	21.1	21.1	10.5	—	—
21-30°	22	(38.5)	4.6	31.8	9.1	22.7	13.6	4.5	4.5	9.1
31-40°	12	(21.1)	8.3	—	8.3	50.0	16.7	8.3	—	—
41-50°	1	(1.8)	—	100.0	—	—	—	—	—	—
Total	57	(100.0)	5.4	22.8	10.5	29.8	17.5	7.0	3.5	3.5

1.4 mm in the normal group and 1.7 mm in the extraction group. The follow-up examination figures showed that the percentage of teeth not in close proximity decreased, as did the distance itself.

The initial angulation (β) of M_3 to M_2 was mesial in both groups (Table II) in 98-99 percent. Parallel angulation was seen in less than 2 percent. During the development and growth of the M_3 teeth the number of distal angulations increased to 14.6 percent in the normal group and to 22.7 percent in the extraction group. Parallel angulations were 6.7 and 5.3 percent, respectively.

The percentage of erupted M_3 teeth was smaller in the normal group, 28.2 percent, than in the extraction group, 35.0 percent; the difference was not statistically significant.

Tables III and IV show that initially the dominant size of the M_3 angle (β) was between 10° and 30° in 71.2 and 71.8 percent, respectively, for the normal and extraction groups. The angulation was 30-40° in about 20 percent in both groups, while the smaller or larger angulations were rare.

The initial angulation shows a tendency to become smaller and to change to parallel and distal angulations during the tooth development. But in spite of this tendency (Tables III and IV) irregularities and changes in the opposite direction can also be seen. Some of the teeth developing from each of the initial angulation groupings remained at the initial angulation or changed to bigger angulations. This can be seen both in the normal and the extraction group.

An overall picture in Figures 4 and 5 shows that the number of teeth with initial angles between 20° and 40° had decreased by more than half, whereas the number of teeth with angles smaller than 10° or with parallel and distal

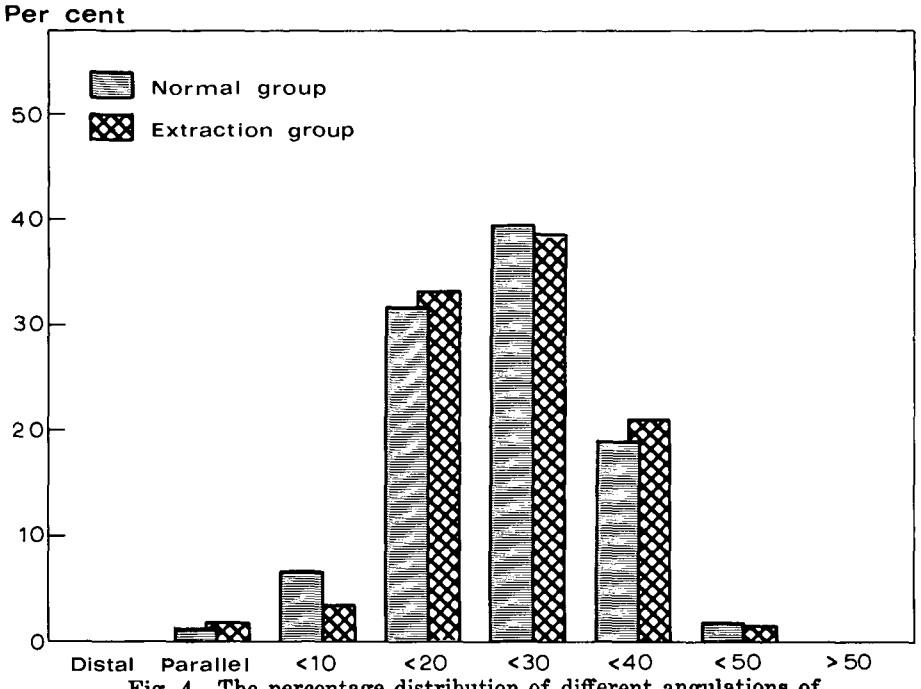


Fig. 4 The percentage distribution of different angulations of M_3 (β angle) initially.

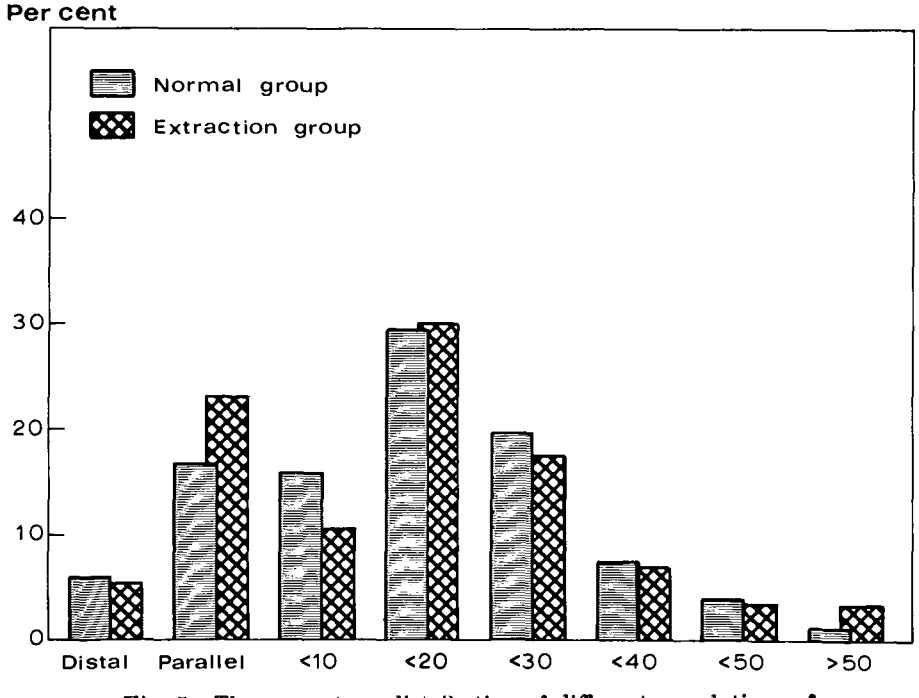


Fig. 5 The percentage distribution of different angulations of M_3 (β angle) at follow-up.

TABLE V

Normal group: Relationship between the initial angulation (β) and the gonial angle (α)

Initial angulation of M_3	No. of teeth	Size of gonial angles and percentage of teeth in each gonial size			
		110-119°	120-129°	130-139°	140-149°
distal					
parallel	2	—	50.0	50.0	—
0.5-10°	10	10.0	70.0	20.0	—
11-20°	51	11.8	41.2	43.1	3.9
21-30°	61	6.6	47.5	45.9	1.6
31-40°	29	10.3	55.2	34.5	—
41-50°	3	—	33.3	66.6	—
Total	156	8.9	47.5	41.7	1.9

TABLE VI

Extraction group: Relationship between the initial angulation (β) and the gonial angle (α).

Initial angulation of M_3	No. of teeth	Size of gonial angles and percentage of teeth in each gonial size			
		110-119°	120-129°	130-139°	140-150°
distal	—	—	—	—	—
parallel	1	—	—	100.0	—
0.5-10°	2	—	50.0	50.0	—
11-20°	20	—	20.0	75.0	5.0
21-30°	23	4.3	26.1	60.9	8.7
31.40°	12	8.3	50.0	41.7	—
41-50°	2	—	100.0	—	—
Total	60	3.3	31.7	60.0	5.0

angulation had increased as had the number of those with angles under and over 50°. The number of teeth with angles between 10° and 20° was almost the same initially as it was at follow-up. Initially, the different angulations were evenly distributed between the two groups. A difference, not statistically significant, between the groups can be seen in follow-up results which show a higher percentage of teeth with parallel and over 50° angulations in the extraction group.

Tables V and VI show that the size of the gonial angle was mostly between 120 and 140 degrees. According to the regression analyses, there was no correlation between the initial angulation of the M_3 and the corresponding gonial angle in the normal group. In the extraction group, however, there were some slight indications suggesting that, when the mesial angulation of M_3 increases, the corresponding gonial angle decreases.

Table VII gives the mean values for gonial angles. The decrease in the gonial angle during the development of the jaws was 2.6° in the normal and 3.9° in the extraction group. The difference between the two groups was not significant.

The mean initial angulation of M_3 (β) was almost the same in both groups, 23.3 and 23.5 degrees (Table VIII). At follow-up the mean value and standard deviation are smaller in the normal group.

Table IX shows that the angulation of M_2 (γ angle) is almost the same initially as it is at follow-up.

Discussion

An earlier work of the present authors[14] and other studies[7,12] showed that an orthopantomogram gives as reliable a

TABLE VII

Combined means of right and left gonial angles at initial and follow-up examinations.

	Gonial angle initially		Gonial angle at follow-up		Decreasing of gonial angle	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Normal	128.1°	5.7°	125.5°	5.8°	2.6°	3.1°
Extraction	130.4°	4.8°	126.5°	5.9°	3.9°	2.7°

TABLE VIII

Combined means of right and left side angulations (β) of M_3 initially and at follow-up, in degrees.

	The mean size of the β angle initially			at follow-up		
	$\bar{x}$	SD	SE	$\bar{x}$	SD	SE
Normal	23.3	9.0	1.0	13.9*	15.1	1.75
Extraction	23.6	9.8	1.76	15.1*	18.4	3.4

* The difference is NS.

TABLE IX

Mean angulation of M_2 to mandibular plane at the initial and follow-up examinations, in degrees.

	The inclination angle (γ) of M_2 initially			at follow-up		
	$\bar{x}$	SD	SE	$\bar{x}$	SD	SE
Normal	87.8	5.8	0.7	87.3	6.5	0.8
Extraction	89.1	6.2	1.2	87.8	7.0	1.3

measurement of the gonial angle as does the lateral skull radiogram. Moreover, the right and left side can be measured separately in an orthopantomogram and without any superimposing. When measuring the angulation of the second and third molars, especially in the early stages of development, the orthopantomogram gives a clear picture again without superimposing. This gave rise to the use of orthopantomograms instead of lateral radiograms.

The results were analysed separately for the left and right sides but were combined for the tables and figures. This could be done because there were no statistical differences between left and right side values. At the individual level there was no significant difference between the left and right side measurements of the gonial angles, the angulation of M_2 or the stages of M_3 development. However, the angulation of M_3 showed more asymmetry at the individual level than the other variables, but there was no significant trend toward either the left or the right side.

At the age of 13.5 years, angulation of M_3 was in 98-99 percent of the cases mesial, the mean value for the β angle being 23°. Most studies report that, in the initial mesial angulation of M_3, the occlusal surface of the crown is facing forward and upward.[3,13,20] The various reports on the angulations of M_3 are difficult to compare, because of the different recording methods used.

Aitasalo et al.[2] in their material with an age range from 20 to 69 years report the prevalence of vertical angulation to be the most frequent, 54 percent, mesioangular in 21.5, horizontal in 22.6, and distoangular in 1 percent.

Morris and Jerman[17] studied panoramic radiographs of 5600 USAF recruits of 19.5 year-old men and found

that the mesioangular position was the most common in 42 percent, followed by the vertical position in 40.7 percent, and distoangular in 8.5 percent.

Richardson[18] in a longitudinal study of 162 children with models and cephalometric radiographs concluded that there was no definite relationship between the early developmental position of the crown of the lower third molar and other dimensions of the teeth and jaws. In the early stages of calcification the lower third molar is tilted mesially forming an angle with the mandibular plane of mean 38° with a range from 11° to 83°, and 55° for the angle between the occlusal plane and the M_3 occlusal surface plane. Silling[20] reports the latter angle to be approximately 40-45 degrees.

In the present material, at age 19.5 years, 71.8 percent of M_3 were impacted in the normal group and 65.0 percent in the extraction group. The difference in the normal and extraction groups was, however, not significant. The results give an impression that the premolar extraction would influence positively the eruption of the lower third molar tooth. More M_3 teeth will probably erupt later, since the mean age of 19.5 years, with a 2.5 years standard deviation, is rather early for the eruption of the tooth. The authors feel justified in saying that all the teeth which had at follow-up a parallel angulation or a less than 10° angulation will be able to erupt (all the distally angulated teeth had already erupted).

In the two groups at the follow-up exactly the same amount, 38 percent, of the teeth were angulated distally, parallel, or less than 10 degrees mesially (Figs. 3 and 4). These were the teeth which had erupted or which will probably erupt. This shows that the positive influence of premolar extraction on the eruption of the M_3 at the mean age of 19.5 years is only plausible. The premolar extractions probably only accelerate the eruption of those M_3 which, without extractions, would erupt later. Some of the teeth with an angulation of more than 10 degrees will probably erupt later, but it is not possible to make any prediction from these results. The percentage of impacted M_3 teeth in the present study is in agreement with that by Morris and Jerman who reported that 65 percent of 19.5 year old men had one to four embedded third molars and Silling who gave a percentage of 67 for males and 69 for females. The many other studies give smaller percentages between 9.5 and 25 percent.[3,6,9,10,15]

According to the results of the regression analyses, the favourable erupting path of M_3 cannot be predicted from the variables used in this study, the size of the gonial angle or the angulation of the M_2 tooth. The most valuable variable was the initial angulation of M_3. The smaller the initial angulation of this tooth, the greater was the chance that the tooth would develop a small angulation favourable for eruption. When the initial angulation of the third molar is less than 10 degrees, the development of the erupting path is favourable; between 10 and 20 degrees the tooth is equally likely to remain at the same angle as to develop a smaller or larger angulation. The larger the initial angle, the greater were the changes toward a smaller angulation but only seldom did the angle become sufficiently small for the eruption of the tooth to be possible.

McBride and Huggins made a cephalometric study of 35 M_3 teeth of 20 orthodontic patients who had undergone extraction of the second molar. Of the teeth 65 percent showed a favourable path of eruption while the remainder showed their position to be less favourable. The authors express the importance of the initial angulation of

the crown and conclude that teeth most favourable for eruption are those which initially have an angulation of less than 50° to the occlusal plane. Richardson[19] studied the development of the lower third molar in an extraction group and a nonextraction group during a period of seven years. She presents factors favourable to the eruption of M_3 to be: extraction of a tooth mesial to the third molar, particularly a molar, a small initial degree of angulation of the developing M_3 to the mandibular plane, and large amount of growth of the mandible.

In the extraction group the changes in the angulation of the lower M_3 tooth were somewhat greater. This shows that the premolar extractions have some influence on the possibility of M_3 eruption but, as said before, the influence seemed to be questionable. Irregularities in the development path could be seen in both groups, but more often in the extraction group. In the extraction group there were more M_3 teeth with good initial angulation, but after the premolar extraction some M_3 did not rotate upwards but downwards at unfavourable horizontal angulation. There may be some special period, possibly that of the beginning of the rotational movement of the tooth, during which some exogene factors may influence the behaviour of M_3.

These results show that the developmental path of the lower wisdom tooth is more complicated and more varying than that of the other teeth. The eruptional behaviour of M_3 may often be exceptional. Further investigations with larger numbers are needed, so that the influence of exceptional cases could be eliminated and investigated separately to find the real reasons for the behaviour of the M_3 tooth.

Conclusions

There was no correlation between the size of the initial and follow-up angulation (β) of M_3 and the gonial angle (α) or the angulation (γ) of the M_2 tooth.

The mean angulation of M_3 (β) at the age of 13.5 years was 23.3° and, at age 19.5 years, 13.9° in the normal group and in the extraction group 23.6° and 15.1°, respectively. The small initial angle is favourable for the eruption of the tooth. When the initial β angle is parallel or less than 10 degrees, M_3 in most cases will erupt. When the initial angle is between 20 and 30 degrees, the possibility of eruption seems to be one in every three cases. With larger initial β angles the prediction of eruption becomes more difficult and the number of impacted cases increases.

In 71.8 percent M_3 was unerupted in the normal group and in 65.0 percent in the extraction group at the age of 19.5 years. The authors, however, expect that the teeth with favourable angulation will eventually erupt, and suggest that the proportion of impacted M_3 teeth will actually be somewhat smaller.

The chances that an M_3 will erupt were occasionally increased by the extraction of premolars but this influence seemed to be only apparent, and the extraction merely accelerates, but does not promote the eruption.

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