European Journal of Orthodontics 20 (1998) 263–270

Third molar impaction in extraction cases treated with the Begg technique

D. Erdem*, E. Özdiler*, U. Toygar Memikoğlu* and E. Başpinar**
Departments of *Orthodontics and **Statistics, University of Ankara, Turkey

SUMMARY The aim of this study was to investigate the differences between two groups of patients with either erupted or impacted mandibular third molars before and after orthodontic treatment. All patients were treated with Begg appliances following extraction of the four first premolars. The erupted group consisted of 14 subjects and the impacted group 13 subjects.

Lateral cephalometric films, peri-apical radiographs, orthopantomographs and orthodontic casts of each subject were taken before and after treatment. Thirteen measurements were carried out on the lateral cephalometric radiographs.

The results revealed slightly more vertical growth and a smaller mandibular arc angle in the erupted group at pre-treatment, and also a more upright lower third molar position and slightly greater distance between the distal point of the lower second molars and the centre of ramus (Xi) in the same group. In the course of treatment, mandibular third molars seemed less likely to erupt when the condyle grew vertically. The lesser resorption on the anterior border of the ramus might have played a part in this finding. In addition, a greater mesial inclination of the mandibular third molars might be an indication of the tendency for these teeth to be impacted in the present study.

Introduction

Mandibular third molars are likely to become impacted and may be associated with pathological processes ranging from simple caries and pericoronitis to cysts and neoplastic lesions. Their role as an aetiological agent of mandibular incisor crowding following orthodontic treatment is controversial (Vego, 1962; Salzmann, 1966; Laskin, 1971; Kaplan, 1974; Lindqvist and Thilander, 1982).

Salzmann (1966) described the beginning of the mandibular third molar development between the ages of 7 and 15 years. The mandibular third molar is formed within the mandibular ramus, and its eruption depends upon the proper development of the body, ramus and angle of the mandible. Mandibular third molars usually begin to calcify with the occlusal surfaces tilted slightly forward and somewhat lingually, and as the mandible increases in length, the roots shift forward, permitting a normal eruption; if this adjustment fails, impaction or ectopic eruption may result.

The literature on third molar impaction seems rather speculative. Eruption or impaction of mandibular third molars has been related to genetic factors (Garn *et al.*, 1962) and even attributed to consequences of eating habits in civilized man (Begg, 1971). Facial growth and development have also proved to be factors directly associated with the position of mandibular third molars (Broadbent, 1943; Ledyard, 1953; Björk *et al.*, 1956; Richardson, 1970, 1977; Kaplan, 1975; Olive and Basford, 1981). Some authors advocate removal of the first mandibular premolar to provide more space for eruption of the third molar (Faubion, 1968; Silling, 1973), whilst others believe that even where first premolars are extracted, mandibular third molars may still remain impacted due to the growth pattern of the face and facial dimensions (Broadbent, 1943; Björk *et al.*, 1956; Shanley, 1962; Kaplan, 1974, 1975; Dierkes, 1975).

Many authors have investigated cephalometric methods for predicting third molar impaction either in extraction or non-extraction treatments, but the results of such studies are inconclusive (Henry and Morant, 1936; McCoy, 1965; Richardson, 1989). In a longitudinal study of 45 premolar extraction and non-extraction cases, Graber and Kaineg (1981) reported that removal of first premolars probably did not enhance normal eruption of third molars. Forsberg (1988) proposed that patients had larger tooth size/arch length discrepancy in extraction compared with non-extraction cases and that this discrepancy might have caused third molar impaction.

In cases of severe crowding, first premolar extraction spaces would be closed to treat dento-alveolar disproportion, leaving little or no space for forward movement of molars. When anterior crowding is less severe, the excess extraction space might be transferred to the molar region by mesial movement of the molars (Richardson, 1989). This would seem to suggest that a 25 per cent increase in space available for the third molars would occur in average cases treated with premolar extraction. Staggers *et al.* (1992) emphasized that the type of mechanics applied and anchorage considerations had more of an effect on third molar angulation than the actual extraction of first premolars.

The aim of this study, therefore, was to investigate the difference between two groups of patients, with either erupted or impacted mandibular third molars, before and after orthodontic treatment with Begg appliances following extraction of four first premolars.

Subjects and methods

This study was based on lateral cephalometric films, orthopantomographs, peri-apical radiographs and orthodontic casts of 27 individuals before and after treatment. Orthodontic records were obtained from the archives of the University of Ankara, Department of Orthodontics.

The criteria used for case selection were as follows: all patients had Angle Class I molar relationships and their ANB angles were between 0–4 degrees. Cast analysis showed moderate crowding [–4 to –6 mm according to the Hays–Nance analysis (Nance, 1947)] for both jaws at the beginning of treatment. Mandibular third molars were present bilaterally. All the subjects were treated with the Begg technique by extracting four first premolars without the use of an extra-oral appliance. During treatment, mesial movement of the molars was allowed after crowding was eliminated. All patients were in the post-pubertal period and apex closure of the third molars was observed on the peri-apical radiographs at the end of treatment.

The sample was then divided into two groups based on the position of the mandibular third molars at the end of the treatment period. The first group (14 patients: nine girls, five boys) had bilaterally erupted mandibular third molars, and the second group (13 patients; 12 girls, one boy) had bilaterally impacted mandibular third molars. Pre- and post-treatment ages, and active orthodontic treatment periods of the groups are given in Table 1 showing distribution homogeneity of the study sample. No significant difference was found prior to the beginning of treatment.

Table 1 Distribution of the study sample according to age and treatment periods (in years).

Pre-treatment			Post-treatment		Treatment period	
Erupted group	Impacted group		Erupted group	Impacted group	Erupted group	Impacted group
$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	test	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$
15.92 ± 0.28	16.99 ± 0.61	ns	17.86 ± 0.30	18.91 ± 0.59	1.94 ± 0.15	1.92 ± 0.18

ns = Non-significant.

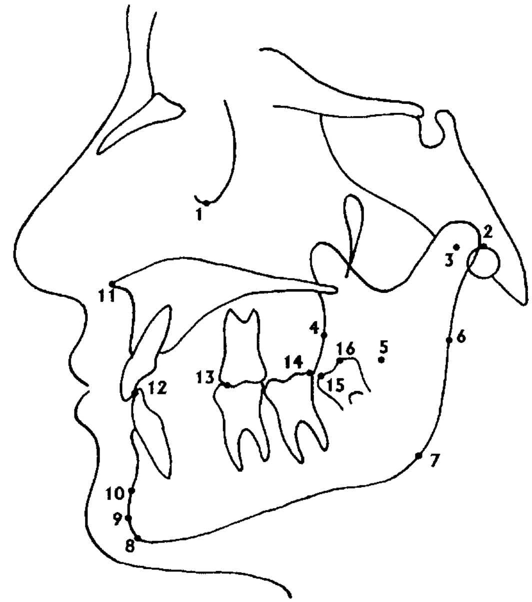

Figure 1 Reference points utilized on the lateral cephalometric films. 1. Orbitale, 2. Porion, 3. DC: the point at the bisection of the condyle neck. 4. R_1: the deepest point on the subcoronoid incisure. 5. Xi: centroid of the ramus (Ricketts *et al.*, 1988). 6. R_2: the point directly opposite to R_1 on the posterior border of the ramus. 7. Gonion, 8. Gnathion, 9. Pogonion, 10. Pm: the point between B and pogonion where the curvature changes from concave to convex. 11. ANS, 12. Incisal point: the midpoint of the incisal edges of upper and lower incisors. 13. Molar occlusal point: the mid-point of the mesial cusp tips of upper and lower first molars. 14. The distal point of $\bar{7}$, 15. $\bar{8}$m: the mesial cusp tip of $\bar{8}$, 16. $\bar{8}$d: the distal cusp tip of $\bar{8}$.

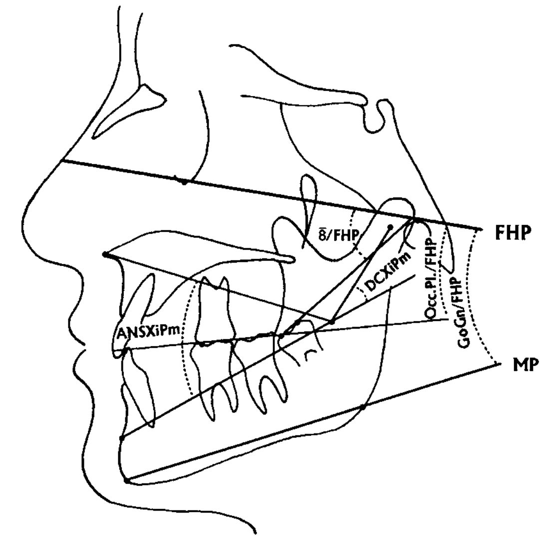

Figure 2 Angular measurements utilized on the lateral cephalometric films. GoGn/FHP: the angle between GoGn line and the Frankfort Horizontal Plane. Occlusal plane/FHP: the angle between occlusal plane and Frankfort horizontal plane. ANSXiPm: the angle between points ANS, Xi and Pm, Xi being the centres (Ricketts *et al.*, 1988). DCXiPm: mandibular arc angle. The angle between points DC, Xi and Pm, Xi being the centres (Ricketts *et al.*, 1988). $\bar{8}$/FHP: the angle between a line constructed by joining the mesial and distal cusps of the lower third molars and the Frankfort Horizontal Plane.

The lateral cephalometric reference points utilized in the study are shown in Figure 1 and the angular and linear measurements in Figures 2 and 3. In the event of double images during landmark identification, the mid-points were used.

Radiographic procedure

Orthopantomographs were used at the beginning of treatment in order to evaluate the presence of bilateral unerupted mandibular third molars overlapped by bone, and peri-apical radiographs were obtained at the end of treatment in order to assess closure of root apices.

The lateral cephalometric films were taken before and after orthodontic treatment. The profile radiographs were recorded with fixed focus to mid-sagittal plane and mid-sagittal to film distances of 150 and 12.5 cm, respectively.

Each reference point was digitized twice. The necessary calculations were performed by using the PorDios (purpose on request digitizer input output system) cephalometric package program (Institute of Orthodontic Computer Science, Århus, Denmark).

Measurement error

In order to determine the error of measurement, lateral cephalograms of 15 patients were randomly selected and the cephalograms were traced again by the same investigator. The coefficient

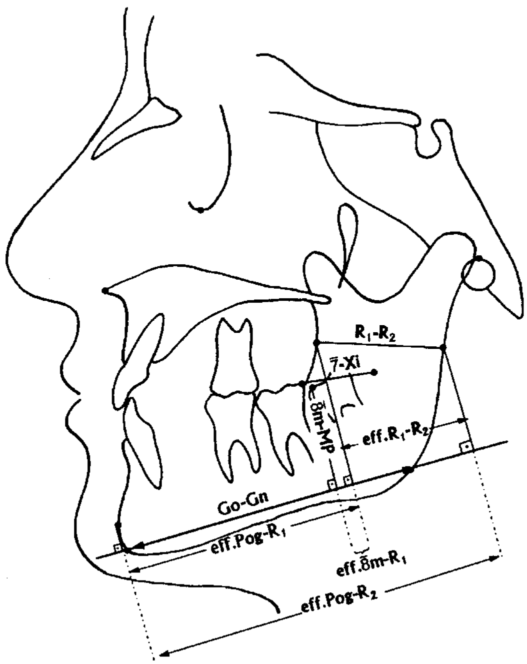

Figure 3 Linear measurements utilized on the lateral cephalometric films. R_1–R_2: the length between R_1 and R_2. Eff. R_1–R_2: the projected length between R_1 and R_2 on the mandibular plane reference line. Eff. Pog–R_1: the projected length between Pog and R_1 on the mandibular plane reference line. Eff. Pog–R_2: the projected length between Pog and R_2 on the mandibular plane reference line. $\bar{7}$–Xi: the length between $\bar{7}$ and Xi. Eff. $\bar{8}$m–R_1: the projected length between $\bar{8}$m and R_1 on the mandibular plane reference line. $\bar{8}$m–MP: the perpendicular distance between mesial cusp tip of $\bar{8}$ and mandibular plane. Go–Gn: the length between gonion and gnathion. *All effective lengths (eff.) are projected lengths on the mandibular plane reference line.

of reliability was calculated (Sokal and Rohlf, 1981). Estimation of random errors is shown in Table 2. It was considered that all measurements were within acceptable limits.

Statistical analysis

Pre-treatment ages of the groups were analysed statistically by Student's *t*-test in order to evaluate homogeneity. The means and standard deviations for all linear and angular cephalometric measurements were calculated, and intra- and inter-group treatment changes were analysed statistically by paired and Student's *t*-test,

Table 2 Reliability of the measurements (n = 15).

Measurements	Coefficient of reliability
GoGn/FHP	0.9982
Occ.Plane/FHP	0.9840
ANSXiPm	0.9971
DcXiPm	0.9876
$\bar{8}$/FHP	0.9849
R_1–R_2	0.9977
Eff. R_1–R_2	0.9878
Eff. Pog–R_1	0.9878
Eff.Pog–R_2	0.9888
$\bar{7}$–Xi	0.9903
Eff. $\bar{8}$m–R_1	0.9877
$\bar{8}$m–MP	0.9865
Go–Gn	0.9989

respectively, using Minitab for Windows version 9 statistical package.

Results

Table 3 shows the descriptive statistical analysis of the erupted and impacted groups, and the statistical evaluation of intra- and inter-group differences.

The differences between the groups before treatment were evaluated by Student's *t*-test and 5 out of 13 showed a statistically significant difference. The erupted group demonstrated slightly more vertical growth (GoGn/FHP), smaller mandibular arc angle (DCXiPm) and more upright position of the third molars ($\bar{8}$/FHP) at the beginning of treatment. The distance between second molars and the centre of ramus ($\bar{7}$–Xi) was slightly greater prior to treatment in the same group.

Treatment changes were evaluated by paired *t*-tests. The following findings were observed during the treatment phase. GoGn/FHP angle increased more in the erupted group compared with the impacted ($P < 0.05$). The width of ramus (R_1–R_2) increased in the impacted group ($P < 0.05$); the distance between the lower second molars and the centre of ramus ($\bar{7}$–Xi), and mandibular third molar height ($\bar{8}$m–MP) increased in both groups; the effective (eff.) Pog–R_1 measurement increased in the erupted

Table 3 Descriptive statistics of the erupted and impacted groups and the statistical evaluation of intra- and inter-group differences.

Measurements	Erupted group Pre-treatment $\bar{x} \pm S_x$	Impacted group Pre-treatment $\bar{x} \pm S_x$	Test	Erupted group Difference $\bar{D} \pm S_x$	Impacted group Difference $\bar{D} \pm S_x$	Test
Angular measurements (°)						
GoGn/FHP	33.95 ± 1.30	29.09 ± 1.60	*	1.43 + 0.62*	0.42 ± 0.86	
Occlusal Plane/FHP	11.01 ± 1.10	11.88 ± 1.00		3.75 ± 0.57***	1.79 ± 1.04	
ANSXiPm	50.86 ± 0.99	46.87 ± 1.40		0.38 ± 0.63	0.07 ± 0.45	
DcXiPm	27.69 ± 1.70	32.97 ± 1.80	*	2.24 ± 1.13	1.19 ± 1.22	
$\bar{8}$/FHP	47.70 ± 3.40	52.35 ± 2.00	*	–4.67 ± 2.49	–1.13 ± 0.45	
Linear measurements (mm)						
R_1–R_2	33.42 ± 0.82	32.10 ± 0.99		–0.80 ± 0.53	1.04 ± 0.48*	*
Eff. R_1–R_2	21.53 ± 1.24	22.02 ± 1.25		–1.62 ± 0.72*	1.56 ± 0.71*	**
Eff. Pog–R_1	62.90 ± 0.99	60.33 ± 1.00		2.20 ± 0.68**	–0.76 ± 1.19**	*
Eff. Pog–R_2	84.43 ± 1.23	82.34 ± 1.36		0.59 ± 0.41	0.80 ± 0.68	
$\bar{7}$–Xi	21.22 ± 0.77	17.59 ± 0.85	**	2.75 ± 0.41***	2.34 ± 0.65**	
Eff. $\bar{8}$m–R_1	9.39 ± 0.62	7.13 ± 0.60	*	2.72 ± 0.72**	0.28 ± 0.72	*
$\bar{8}$m–MP	24.50 ± 1.00	22.30 ± 0.74		3.12 ± 0.48***	1.02 ± 0.39*	**
Go–Gn	75.81 ± 1.20	74.82 ± 1.40		–0.04 ± 0.34	0.55 ± 0.25*	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

group, while it decreased in the impacted group ($P < 0.01$); and there was an increase in distance eff. $\bar{8}$m–R_1 in the erupted group ($P < 0.01$).

When changes during treatment in the two groups were compared, statistically significant differences were observed only in linear measurements. During treatment, the width of ramus was increased in the impacted group, while eff. Pog–R_1 and eff. $\bar{8}$m–R_1 lengths increased more in the erupted group ($P < 0.05$). $\bar{8}$m–MP length increased more in the erupted group compared with the impacted group and the difference between the groups was significant ($P < 0.01$).

Discussion

The predictability of lower third molar eruption in extraction cases remains poor. In order to gain insight into this clinical problem, this study compared two groups of patients with either erupted or impacted mandibular third molars.

Ledyard (1953) found that further growth in the retromolar area was negligible after 17 years of age. Therefore, all the individuals in this study had reached 17 years at the end of orthodontic treatment.

In this study, GoGn/FHP angle was larger both at the beginning and end of treatment in the erupted group ($P < 0.05$). Although the difference between the groups was not significant, this angle increased more during treatment in the erupted group. At the same time ANSXiPm angle, which shows the vertical direction of lower facial growth, was higher in the erupted group, and this supports the above result in spite of the statistical insignificance. However, in Capelli's study (1990), the GoGn/FHP angle was high both at the beginning and at the end of treatment in the impacted group, which is inconsistent with the results of our study.

DCXiPm angle, which indicates the growth direction of the condyle in relation to mandibular corpus, was larger in the impacted group at pre-treatment and the difference was statistically significant ($P < 0.05$). This slight increase in DCXiPm angle might be an indication of a more vertical direction of condylar growth in the impacted group.

The above results suggest that vertical growth direction of the condyle and anterior rotation of the mandible may be associated with the impaction of third molars even in cases where premolars have been extracted. Our results are consistent with those of previous studies (Björk *et al.*, 1956; Kaplan, 1975; Björk and Skieller, 1983). Björk *et al.* (1956) stated that vertical direction of condylar growth would result in little resorption on the anterior border of ramus and might contribute to insufficiency of space for the eruption of the third molars. The ArGnGo angle which was used in Kaplan's study (1975) is similar to the DCXiPm angle used in the present study. Kaplan found that vertical condylar growth was more in the impacted group compared with the erupted group. Supporting the same point of view, Björk and Skieller (1983) reported that when backward directed growth occurred at the condyles, there would be marked resorption on the anterior border of the ramus.

The initial angulation of the third molar to the Frankfort Horizontal Plane ($\bar{8}$/FHP) was smaller in the erupted group ($P < 0.05$) and the decrease in this angle was more in the erupted compared with the impacted group, although the difference was not statistically significant (Table 3). $\bar{8}$m–MP which also shows the height of the third molars was similar in both groups at the beginning of treatment. This length increased more in the erupted group during treatment and the difference between the two groups was also significant ($P < 0.01$). The changes showed that during treatment the third molars uprighted and elevated more in the erupted group, which facilitated their eruption. These findings agree with the study of Richardson (1989) who found that third molars with a small degree of angulation erupted earlier than those with steeper angulations. On the other hand, Staggers *et al.* (1992) believed that orthodontic treatment involving premolar extractions did not improve third molar angulation.

In the present study, there was no difference in eff. Pog–R_1, eff. Pog–R_2, eff. R_1–R_2 and R_1–R_2 lengths between the two study groups before treatment. Ramus width decreased in the erupted group while it increased in the impacted group during treatment (R_1–R_2 $P < 0.05$, eff. R_1–R_2 $P < 0.01$). The measurements eff. Pog–R_1 and eff. Pog–R_2 were used to examine these changes further. According to growth studies (Ledyard, 1953; Björk, 1963; Björk and Skieller, 1983), there seems to be little or no change during the post-pubertal growth period in the symphysis region and pogonion. Although there may be some remodelling activity in lower border of the mandible (Björk and Skieller, 1983), it can still be speculated that any difference in eff. Pog–R_1 length during treatment would probably originate from the relocation of point R_1, which would suggest resorption at the anterior border of the ramus. An increase which occurs in this measurement or with R_2 point would suggest apposition at the posterior border of the ramus. The eff. Pog–R_2 measurement increased in both groups but the difference between the groups was not significant. However, eff. Pog–R_1 length increased significantly in the erupted group and decreased significantly in the impacted group during treatment ($P < 0.01$). These two measurements might be an indication that the cause for decrease of R_1–R_2 width in the erupted group was the anterior resorption of the ramus (eff. Pog–R_1), whilst the reverse was valid for the impacted group.

The distance between the distal point of the second molar and centre of ramus ($\bar{7}$-Xi) was higher in the erupted group at the beginning of treatment. During treatment this distance increased more in the erupted group ($P < 0.001$) than in the impacted group ($P < 0.01$). However the difference between the two groups was not significant. Eff. $\bar{8}$m–R_1 length was larger pre-treatment in the erupted group ($P < 0.05$) and this length increased during treatment in the same group ($P < 0.01$), and the difference between the two groups was significant at the end of treatment ($P < 0.05$).

These results would indicate that in the erupted group there was more resorption on the anterior border of the ramus and this resorption might be partially responsible for the eruption of the third molars by providing the necessary space.

Ricketts (1972) and Silling (1973) believe that impaction of the third molars is related to the insufficient distance between second molars and ascending ramus.

Björk *et al.* (1956) made a detailed study of third molar impaction and stated that failure of the mandibular third molars to erupt completely was usually associated with lack of space between the second molar and the ascending ramus. Insufficient space, therefore, is the main cause of impaction. They identified three factors that separately influenced third molar impaction: (i) reduced growth in mandibular length; (ii) a vertical direction of condylar growth and (iii) a distal pattern of eruption of the mandibular dentition, and concluded that insufficient space for the third molars was the essential cause of their incomplete eruption.

The difference in length of the mandibular corpus (Go–Gn) was not statistically significant between groups. This finding agrees with the studies of Dierkes (1975) and Kaplan (1975). However, in Capelli's study (1990) the length of the mandibular corpus was less in the impacted third molar group.

Conclusions

1. Impaction of lower third molars is unpredictable, even where orthodontic treatment has allowed some mesial movement of the lower second molars.
2. The chances of eruption of mandibular third molars may increase with a more vertical facial growth pattern.
3. When the direction of condylar growth tends to be vertical and the mandible tends to rotate anteriorly, mandibular third molars may be less likely to erupt as there may be less resorption on the anterior border of the ramus.
4. A greater mesial inclination of the mandibular third molars may be an indication of the tendency for these teeth to remain impacted even following extraction treatment.

Address for correspondence

Dr Ufuk Toygar Memikoğlu
Ankara Üniversitesi
Diş Hekimligi Fakültesi
Ortodonti Anabilim Dalı
06500 Beşevler, Ankara
Turkey

References

Begg P R 1971 Begg orthodontic theory and technique. Philadelphia: W B Saunders Company

Björk A 1963 Variations in the growth pattern of the human mandible: longitudinal radiographic study by the implant method. Journal of Dental Research, Suppl. 1 42: 400–411

Björk A, Skieller V 1983 Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. European Journal of Orthodontics 5: 1–46

Björk A, Jensen E, Palling M 1956 Mandibular growth and third molar impaction. Acta Odontologica Scandinavica 14: 231–272

Broadbent B H 1943 The influence of the third molars on the alignment of the teeth. American Journal of Orthodontic and Oral Surgery 29: 312–330

Capelli J 1990 Mandibular growth and third molar impaction in extraction cases. Angle Orthodontist 61: 223–229

Dierkes D D 1975 An investigation of the mandibular third molars in orthodontic cases. Angle Orthodontist 45: 207–212

Faubion B H 1968 Effect of extractions of premolars on eruption of mandibular third molars. Journal of the American Dental Association 76: 316–320

Forsberg C-M 1988 Tooth size, spacing, and crowding in relation to eruption or impaction of third molars. American Journal of Orthodontics and Dentofacial Orthopedics 94: 57–62

Garn S M, Lewis A B, Bonne B 1962 Third molar formation and its development course. Angle Orthodontist 32: 270–278

Graber T M, Kaineg T F 1981 The mandibular third molar—its predictive status and role in lower incisor crowding. Proceedings of the Finnish Dental Society 77: 37–44

Henry C B, Morant G M 1936 A preliminary study of the eruption of the mandibular third molar tooth in man based on measurements obtained from radiographs, with special reference to the problem of predicting cases ultimate impaction of the tooth. Biometrika 28: 378–427

Kaplan R G 1974 Mandibular third molars and post-retention crowding. American Journal of Orthodontics 66: 411–430

Kaplan R G 1975 Some factors related to mandibular third molar impaction. Angle Orthodontist 45: 153–158

Laskin D M 1971 Evaluation of the third molar problem. Journal of the American Dental Association 82: 824

Ledyard B C Jr 1953 A study of the mandibular third molar area. American Journal of Orthodontics 39: 366–372

Lindqvist B, Thilander B 1982 Extraction of third molars in cases of anticipated crowding in the lower jaw. American Journal of Orthodontics 81: 130–139

McCoy J R 1965 A study of growth potential. American Journal of Orthodontics 51: 79–97

Nance N H 1947 The limitations of orthodontic treatment: II. Diagnosis and treatment in the permanent dentition. American Journal of Orthodontics and Oral Surgery 33: 253–301

Olive R J, Basford K E 1981 Transverse dentoskeletal relationship and third molar impaction. Angle Orthodontist 51: 41–47

Richardson M E 1970 The early developmental position of the lower third molar relative to certain jaw dimensions. Angle Orthodontist 40: 226–230

Richardson M E 1977 The etiology and prediction of mandibular third molar impaction. Angle Orthodontist 47: 165–172

Richardson M E 1989 The effect of mandibular first premolar extraction on third molar space. Angle Orthodontist 59: 291–294

Ricketts R M 1972 A principle of archial growth of the mandible. Angle Orthodontist 42: 368–386

Ricketts R M, Bench R W, Gugino C F, Hillgers J J, Schulhoff R J 1988 Bioprogressive therapy. Dr Alfred Hüthig Verlag GmbH, Heidelberg

Salzmann J A 1966 Practice of orthodontics, Volume 1. J B Lippincott Company, Philadelphia

Shanley L S 1962 Influence of mandibular third molars on mandibular anterior teeth. American Journal of Orthodontics 48: 786–787

Silling G 1973 Development and eruption of mandibular third molar and its response to orthodontic therapy. Angle Orthodontist 43: 271–278

Sokal R R, Rohlf F J 1981 Biometry. W H Freeman Company, San Francisco

Staggers J A, Germane N, Fortson W M 1992 A comparison of the effects of first premolar extractions on third molar angulation. Angle Orthodontist 62: 135–138

Vego L 1962 A longitudinal study of mandibular arch perimeter. Angle Orthodontist 32: 187–192