Spatial Position of Mandibular Third Molars in Monozygotic Twins

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Measurement of anterior and medial inclinations of third molars from 10 to 18 years of age in monozygotic twins finds a consistent pattern of uprighting, with high correlations within twin pairs indicative of strong genetic influence.

KEY WORDS: GENETICS, THIRD MOLARS, TWINS

Mandibular third molars develop relatively late in life, and in a markedly inclined position from which they must upright in order to erupt into the mouth. This uprighting is of considerable interest for the prognosis of third molar impaction. It has been studied extensively by RICHARDSON (1970, 1973, 1974, 1975, 1977) AND BY ALTONEN, HAAVIKKO AND MATTILA (1977).

RICHARDSON (1970) determined third molar inclination in 162 children with a mean age of 11.1 years by measuring the angle between the occlusal surface of the third molar crown and the mandibular plane. At this early developmental level, third molar inclination ranged from 11° to as much as 83° with an average of 38°. She was unable to detect any definite relationship between the early developmental position of the mandibular third molar and other dimensions of teeth and jaws.

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Between 10 and 15 years of age, an average decrease of 11.2° occurred in the angle of the mandibular third molar to the mandibular plane. The larger the angle at 10 years, the more the third molar uprighted in the ensuing 5 years. This change in angulation seemed to be independent of growth changes in the mandible (RICHARDSON 1973).

Early emergence of third molars was associated with a low initial angulation or a large amount of change in the angulation of developing third molars to the mandibular plane (RICHARDSON 1974). Richardson also states that extraction, particularly of first or second molars in the same arch segment, accelerated eruption of third molars, confirming the findings of FANNING (1962) on third molar emergence in Bostonians.

Accurate prediction of third molar impaction has not been possible at early developmental levels, but mandibular third molars which were markedly inclined at an early developmental stage did show a greater than average probability of becoming impacted, particularly in the presence of a full complement of buccal teeth (RICHARDSON 1975, 1977).

RICHARDSON (1978) considered relative lengthening of the mesial root to be the mechanism responsible for uprighting and eruption of mandibular third molars, while greater growth of the distal root produced more severe mesial inclination and possibly horizontal impaction.

In a study of a large cross-sectional group of orthopantomographs by HAAVIKKO ET AL (1978), the angulation of the mandibular third molars was evaluated in relation to the longitudinal axis of the adjacent mandibular second molar. This angle was shown to decrease more rapidly after puberty than before.

Longitudinal data of these investigators, also based on orthopantomographs, suggests that even though prediction of mandibular third molar eruption is not possible, the initial angulation appears to be the most important factor. A small initial angulation suggests an unimpeded eruption path.

BJÖRK ET AL. (1956), on the other hand, concluded that "the prospects of estimating the risk of impaction from the degree of inclination of M_3 at a pre-adolescent stage do not appear to be promising."

SHILLER (1979) reports significant positional changes in mesially-inclined mandibular third molars in 18- to 20-year-old males within the relatively short time span of one year.

Although the formation and crown size of mandibular third molars are, to a large extent, under genetic control (GARN ET AL. 1962, GARN 1977), it is not known whether the inclination of the developing mandibular third molar is mainly under genetic or environmental influence.

To help resolve the question of genetic vs. environmental influence, the present investigation was undertaken to study —

- The spatial orientation (inclination) of the mandibular third molars in the sagittal and frontal planes during the course of their development from age 10 to 18 years.
- Left-right symmetry of third molar position in individuals at successive age levels.
- The relation between sagittal and frontal inclination of third molars at successive ages from 10 to 18 years.
- The relationship of third molar inclination within identical twin pairs, in an effort to assess factors controlling their inclination.
- The uprighting of third molars on a developmental scale based on tooth formation, rather than on a chronologic scale.

— Materials and Methods —

Serial oblique lateral jaw and postero-anterior cephalometric radiographs of 41 monozygotic twin pairs (25 boys and 16 girls), exposed within ±2 weeks of annual birthdays from 10 to 18 years of age, were selected from the files of the longitudinal growth study of twins and their age-matched siblings at the Forsyth Dental Center.

Slight to moderate malocclusions, normal occlusions, and a variety of skeletal patterns were encountered in this sample of monozygotic twins. None of the dentitions were mutilated by extraction of permanent teeth, and none of the subjects had received orthodontic treatment.

The anterior inclination of left and right third molars as seen in sagittal projection was measured on the lateral jaw radiographs as the angle between the occlusal surface of the third molar and the occlusal surface of the permanent first molar (Fig. 1). The angles were recorded in increments of 5° from 0° to 90°.

The reference line was based on the occlusal surface of the first molar rather than the second molar, because the first molar represents a more stable, well-established landmark through the early stages of third molar crown formation.

Medial inclination of the third molar, as seen in frontal projection on P-A cephalographs, was recorded in increments of 5° with reference to the midline of the face (Fig.2).

The extent of crown and root formation of mandibular third molars was determined from lateral jaw radiographs and classified according to MOORREES ET AL. (1963) in one of the following stages of tooth development (Fig. 3):

1 cusp outline complete (Coc)
2 half crown complete (Cr ½)
3 crown complete (Crc)
4 one-fourth root formation (R ¼)
5 half root formation (R ½)
6 three-quarter root formation (R ¾)
7 root complete (Rc)

The time period represented by each stage ranges from its initial attainment up to attainment of the next stage.

— Findings —

At ten years of age, the crowns of mandibular third molars were markedly inclined both mesially and lingually. In the time span between 10 and 18 years, they gradually uprighted. The medial inclination in the frontal (P-A) projection decreased gradually from 70° at age 10 to 45° at 18 (Fig. 4). Anterior inclination in the lateral (sagittal) projection decreased from 55° to 25° in the same period (Fig. 5).

Third molar inclination varied widely among individuals at all ages. For example, at 10 years of age the 10TH percentile level was 53° and the 90TH percentile 88°, a range of 35° (Fig. 4). The median angle at that age was 70°, demonstrating the fallacy of relying on median values alone.

In these tabulations, findings on the left and right sides for each individual were combined, because the inclination of left and right third molars was rather symmetrical. Left-right correlation coefficients were moderate to high at all ages except 18 years, with an overall median correlation coefficient of 0.65 for both frontal and sagittal projections (Table 1).

Correlations were also strong between inclinations in frontal and sagittal projections. Averaging left and right values for each individual, r ranged from 0.70 to 0.77, and the median correlation coefficient was 0.72 (Table 2). A scatter plot of the association between third molar inclination in the frontal and sagittal planes at age 14 years (r=0.74) is shown in Fig. 6.

In view of the known individual variability in the timing of third molar devel-

Fig. 1 The anterior inclination of mandibular third molars in sagittal projection was measured as the angle between a line tangent to the occlusal surface of the third molar and a line tangent to the occlusal surface of the permanent first molar.

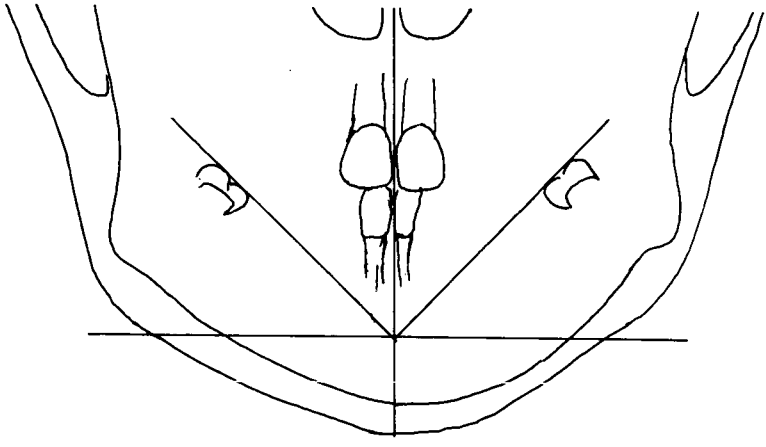


Fig. 2 The medial inclination of mandibular third molars as seen in frontal projection was measured as the angle between a midfacial reference line and a line tangent to the occlusal surface of the third molar

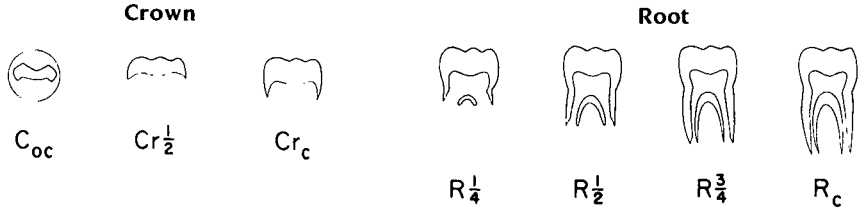


Fig. 3 Stages of crown and root formation define a biologic reference scale that may be used as an alternative to chronologic age for studying the uprighting of mandibular third molars.

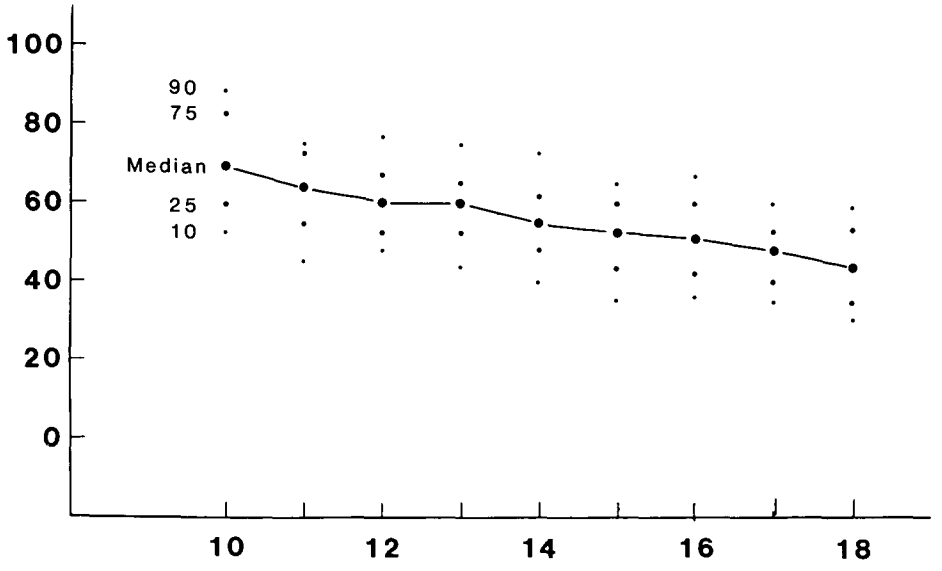


Fig. 4 Median angles and percentile distributions of medial third molar inclination in frontal projection at one-year age intervals from 10 to 18 years.

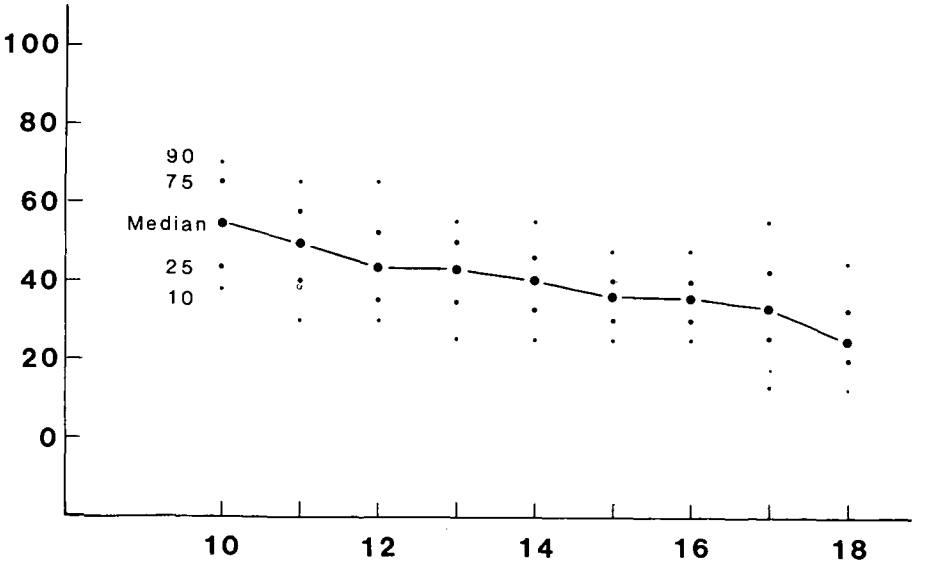


Fig. 5 Median angles and percentile distributions of anterior third molar inclination in sagittal projection at one-year age intervals from 10 to 18 years. Angles of inclination of left and right molars were averaged to obtain a single value at each annual examination.

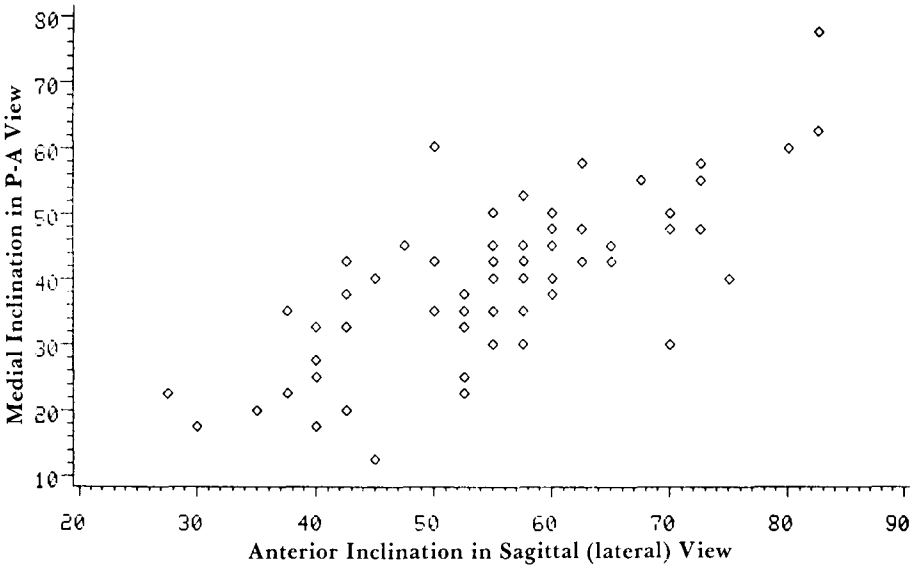


Fig. 6 Scattergram showing association (r=0.74) between medial (lingual) and anterior angles of third molar inclination at age 14 years. Values shown are averages of left and right.

opment, mean angles of third molar inclination in frontal and sagittal projection for each formation stage that was encountered at each chronologic age were determined. The number of formation stages seen at any one chronologic age ranged from 2 stages at 10 years to 6 stages at 15 (Figs. 7 and 8).

Mean angles for early developmental stages at any given age were always greater than the means for more mature developmental stages at the same chronologic age. For instance, at 15 years of age the mean frontal angle for stage 2 was 70° and the mean angle for stage 7 was 38° (Fig.7).

This wide variation in the extent of third molar development at each chronologic age suggests that the process of third molar uprighting could be studied more advantageously by grouping the data with reference to a biologic age scale based on crown and root formation (Figs.9 and 10). Third molars in the same stage of development have greater similarity in their angles of inclination than those of subjects at the same chronologic age (Figs. 7 and 8).

Within monozygotic twin pairs, correlations showed a high degree of association of third molar inclination. During crown formation (stages 1-3), r=0.82. During early root formation (stages 4 and 5), r=0.82 in the frontal projection. For forward inclination as seen in the lateral projection, r=0.74 at stage 4 and r=0.80 at stage 5.

Inclination during late root formation within 16 twin pairs showed only moderate correlation coefficients for anterior inclination in the sagittal plane (r=0.61), and very low for medial inclination in the frontal plane (r=0.21) (Table 3).

Serial plots of third molar inclination in two pairs of identical twins show remarkable parallelism in the uprighting,

Table 1

Left vs. Right Angle Correlations by Age

Age	Lat	P-A	N
10	.81	.72	18
11	.65	.55	45
12	.67	.60	57
13	.51	.66	64
14	.67	.65	63
15	.63	.73	50
16	.55	.70	49
17	.80	.48	36
18	.38	.35	20
Median r	.65		

Table 2

P-A vs Sagittal Angle (L+R) Correlations by Age

Age	No.	r
10	25	.77
11	47	.70
12	60	.73
13	71	.70
14	68	.74
15	59	.77
16	53	.64
17	36	.72
18	22	.70
Median r		.72

Table 3

Monozygotic Twin Pair Correlations by Formation Stages

	P-A (medial)	Sagittal (anterior)	No. of Pairs
Crown (1-3)	.82	.74	40
Early Root (4-5)	.82	.80	28
Late Root (6,7)	.21	.61	16

and close agreement of values at each stage, occasionally even displaying identical values in both the sagittal and frontal planes (Fig. 11).

— Discussion —

Third molar development occurs relatively late in the life of a child. Crypt formation in the mandible begins shortly before nine years of age in the average child, and in approximately one year the crypt has enlarged and calcification of the crown has advanced to the stage "crown outline complete." At 13 years of age the crown is formed and root formation is under way.

These approximations of median ages at which attainment of various stages of third molar development occurred in the

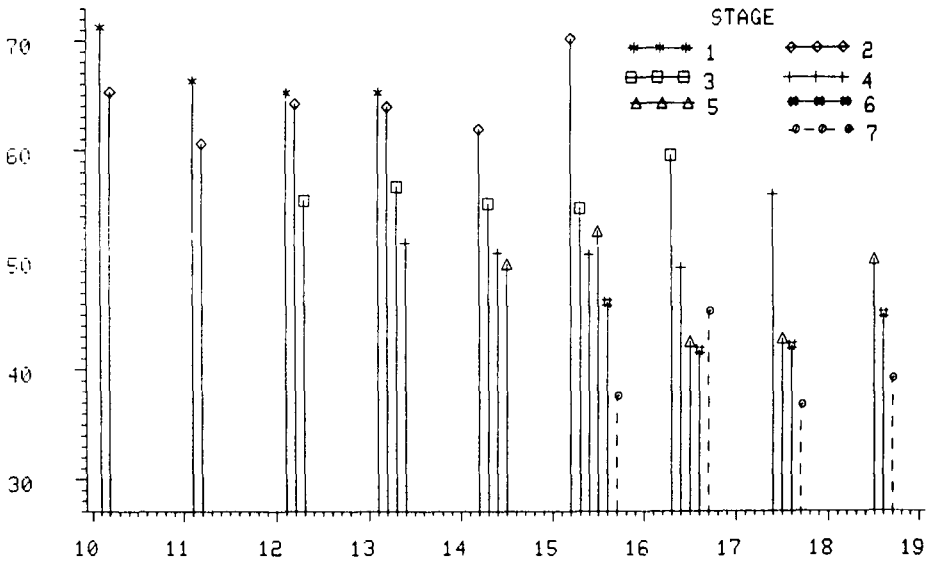


Fig. 7 Mean medial angles of third molar inclination in frontal projection, showing formation stages at each chronologic age level. Mean angles of inclination vary markedly at each chronologic age according to the stage of root formation, with third molar inclination becoming progressively smaller at later stages. In contrast, mean values for individuals at the same stage are quite similar, regardless of differences in chronologic age.

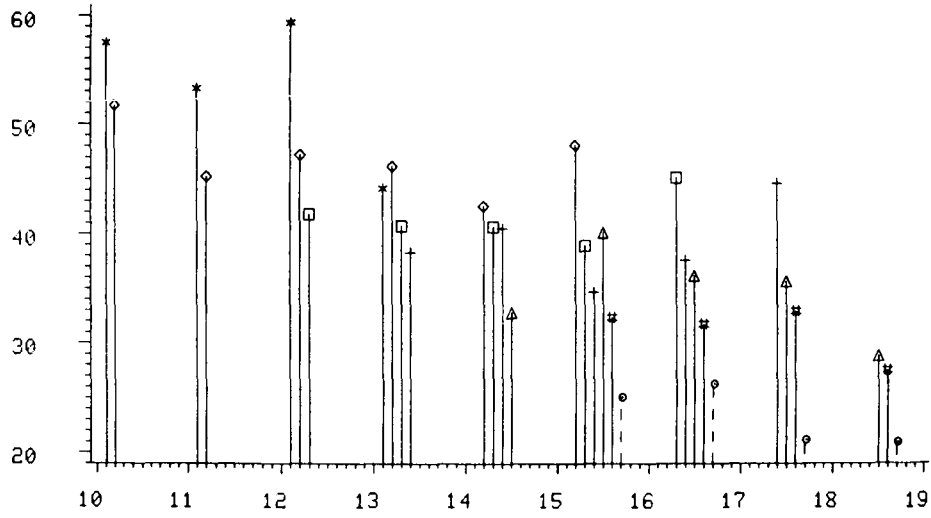


Fig. 8 Mean angle of anterior third molar inclination in sagittal projection, showing formation stages at each chronologic age level (See legend of Fig. 7).

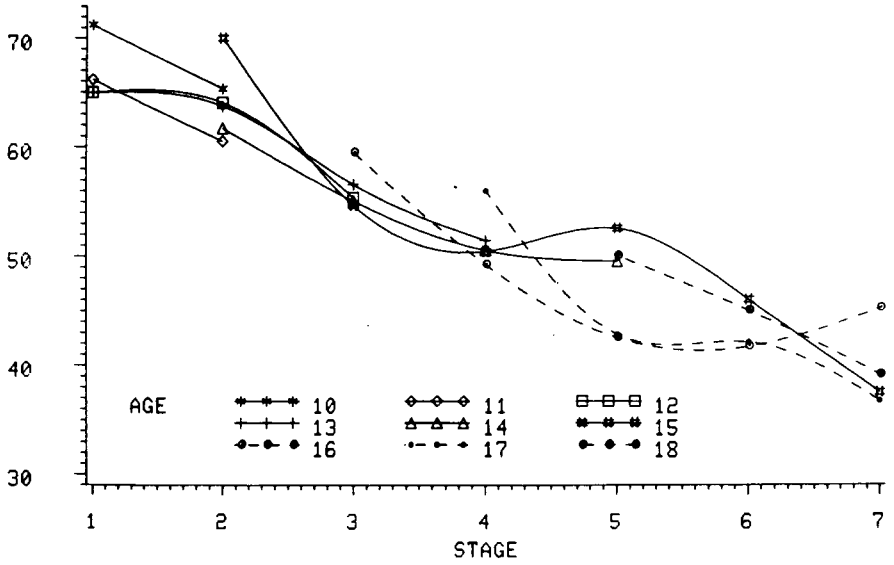


Fig. 9 Mean angle of medial third molar inclination in frontal projection for each chronologic age that was encountered at successive formation stages. Third molar inclination for individuals at the same formation stage is remarkably consistent over a broad range of age.

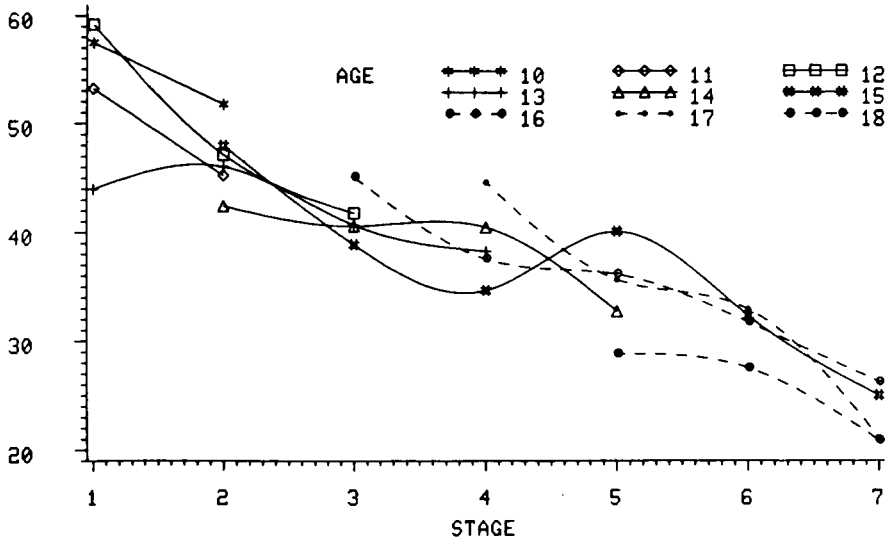


Fig. 10 Mean angles of anterior third molar inclination in sagittal projection for each chronologic age encountered at successive formation stages (See legend of Fig. 9).

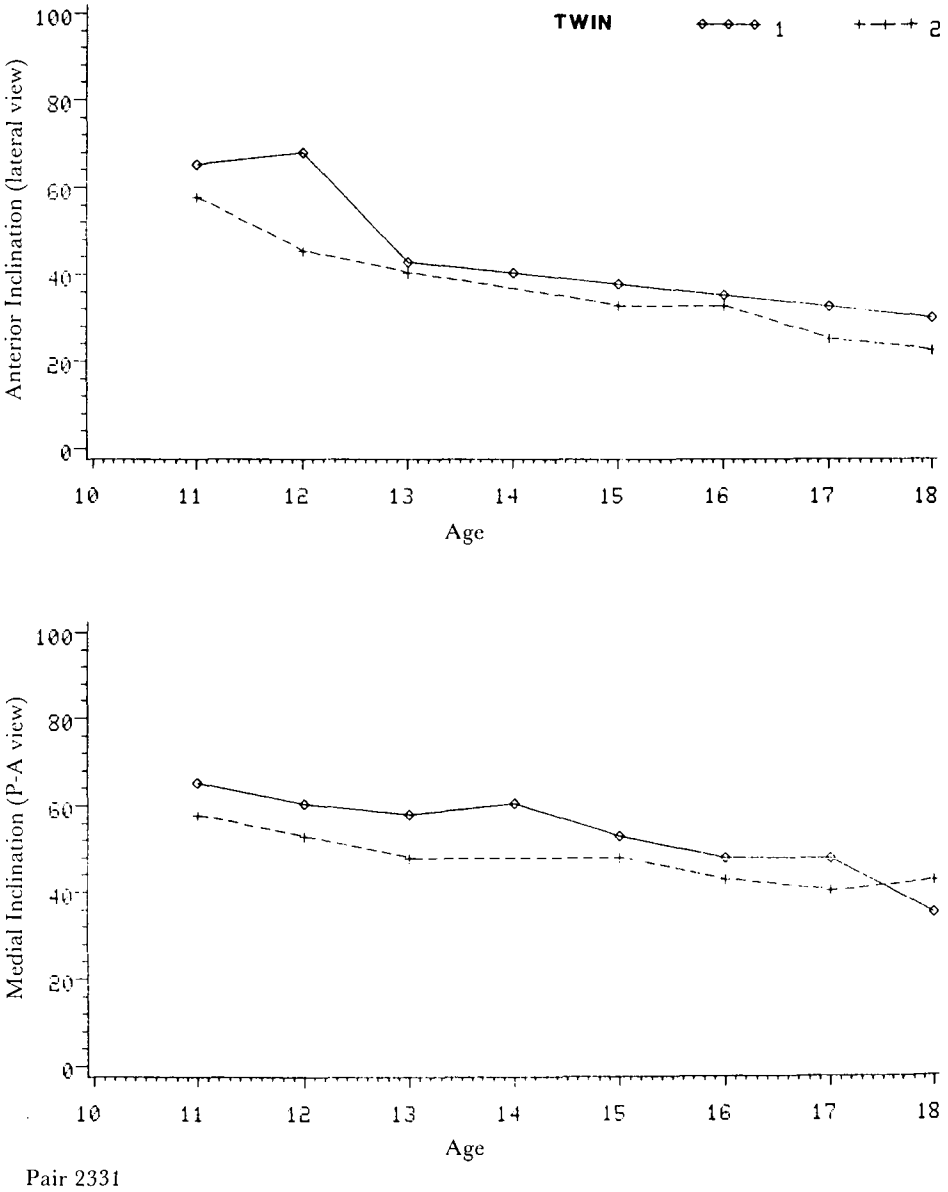
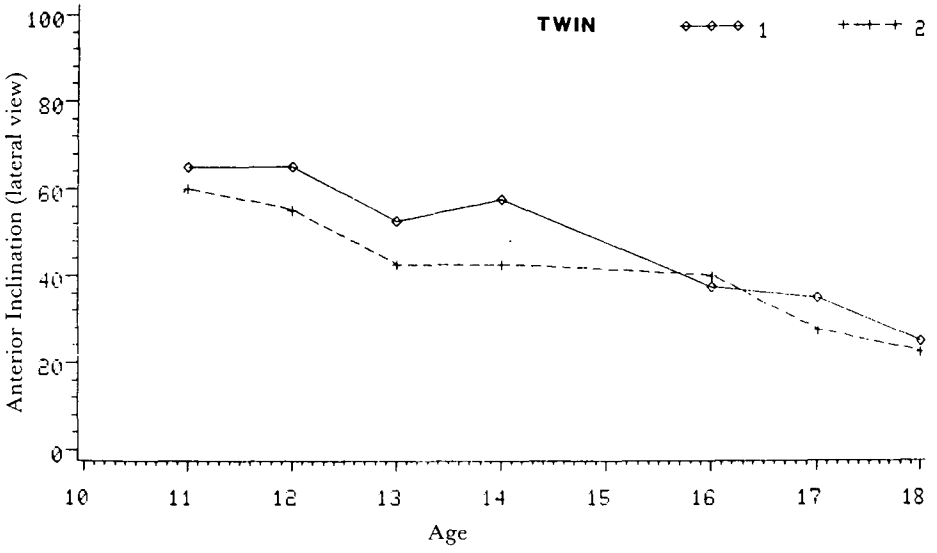
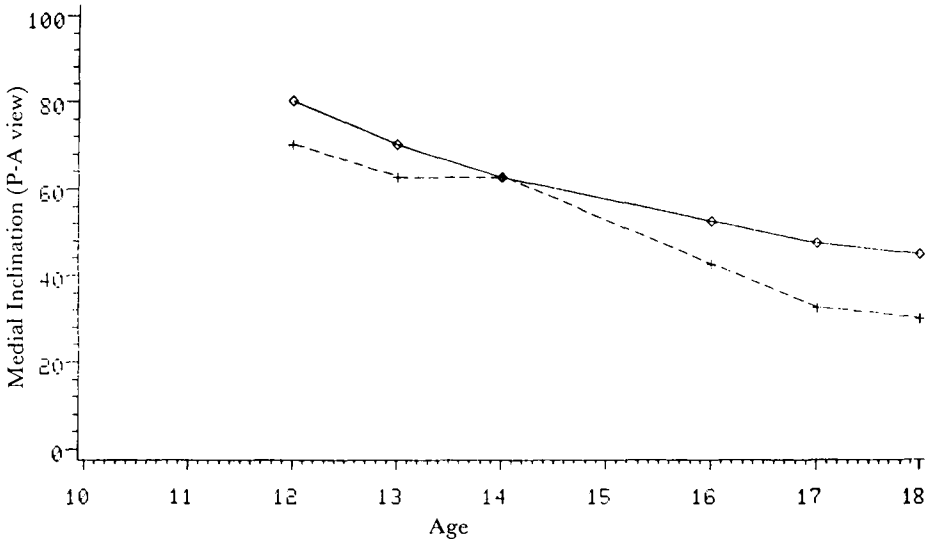


Fig. 11 **Close concordance in third molar uprighting measured in frontal and sagittal projections between 10 and 18 years in two pairs of monozygotic twins** *(above, Pair 2331; right, Pair 0111).*





Pair 0111

Forsyth longitudinal study of twins must be viewed against a wide range of individual variation in the attainment of each stage. The range from −2 to +2 standard deviations roughly spans a period of as much as 6 years.

The wide discrepancy observed in the extent of third molar development at each chronologic age indicates that third molar uprighting should be studied by grouping the data with reference to a biological age scale based on crown and root formation stages.

The findings of the present study reemphasize that normal third molars have considerable mesial (anterior) and lingual (medial) inclinations from which they gradually upright in their path of eruption into the mouth. This uprighting simultaneously reduces the mesial and lingual tilting of mandibular third molars, as shown by the high correlation (r=0.72) reported in Table 2.

The mesiolingual inclination showed considerable symmetry at all ages, with a median left-right correlation of 0.65 (Table 1).

The high correlation within monozygotic twin pairs in both the mesial (anterior) and lingual (medial) inclinations was a remarkable finding. This demonstrates close similarity in the inclination of the late-developing tooth as it uprights from its early crown formation stages through root formation.

The low (r=0.21) correlation at ¾ and full root length stages in the P–A view is probably a reflection of the difficulty in ascertaining the exact angulation of the tooth in frontal projection at its mature stage of development when it is close to alveolar eruption. The small sample size at this stage also affects the correlation.

All findings of this study demonstrate close agreement in the development, initial position and uprighting of mandibular third molars within monozygotic twin pairs. This strongly suggests major genetic impact on the normal course of third molar development and eruption toward its emergence, with a relatively minor environmental contribution.

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