Dental Research Unit. University of Bristol Dental School (England)

Incisor growth in twins during the seventh and eighth months of foetal life

Maurice V. Stack

The first odotometric study of twins suitable for tests of statistical significance was that by Horowitz, Osborne & DeGeorge (1958). They were able to assess the contribution of hereditary factors to variability of mesiodistal diameters of incisors in a group of 54 pairs of adult twins. Variations in dental growth of twins is of particular interest at an early stage in formation. It has been possible over a number of years to dissect ten sets of deciduous incisors from pairs of twins failing to survive premature birth. These have been compared with developing teeth of similar maturity in order to test the data from the twin group by the analysis of variance.

The present study is based upon all dissected incisors from ten pairs of twin foetuses delivered after 24-32 weeks' gestation, according to estimates of age from these teeth. The incisors were dried to constant weight after brief rinsing. Weights were determined to the nearest 0.1-0.2 mg. Mesiodistal widths and crown heights were determined by micrometer to the nearest 0.02 mm. on central incisors from the most advanced pairs of twins and from four foetuses of similar maturity.

Data on duration of gestation, body weight, and pathological factors noted at autopsy were recorded from hospital data. Only one pair of twins known to be monozygotic was noted, and this was not included in the study group because relative development of the incisors differed from that of the group studied. Two of the seven pairs of like sex were known to be dizygotic. It is thus not possible to separate genetic and environmental contributions to the variations disclosed. Intra- and inter-pair variabilities were compared after processing the data so as to reduce trends due to growth. The data were transformed into logarithmic units when these were found to increase in proportion to age, and the age factor was then minimised by using internal comparisons (ratios of log units for lower: upper teeth).

Table 1 has been arranged so that each pair of rows of incisor weight data for the twin foetuses has been separated by a row of data on a foetus of similar incisor development, but not representative of a multiple birth. This row was then compared with the twin row above or below, the choice being indicated by the link at the margin. Foetal ages were recorded in days from the clinical notes giving estimated dates of delivery, except in six instances where duration of gestation was known to the nearest

Tab. 1. Weights of incisor pairs from premature infants in relation to recorded and estimated durations of gestation

Case no.	Sex	Weights (mg)				Duration of gestation [1]		Body weight (kg)
		Upper		Lower				
		$\underline{a}$ Central	$\underline{b}$ Lateral	$\overline{a}$ Central	$\overline{b}$ Lateral	Recorded [2]	Estimated	
J I	♂	5.6	2.0	4.0	1.8	179	175	0.66
73	♂	5.6	2.8	3.2	1.0	(168)	172	0.82
J II	♂	5.1	1.8	3.6	1.6	179	172	0.66
K I	♀	6.3	3.1	4.3	2.2	173	178	0.63
68	♀	6.6	4.0	5.8	2.8	183	181	0.81
K II	♀	5.4	2.1	3.6	1.8	173	173	0.52
L I	♀	9.2	5.0	4.4	1.5	(168)	182	0.69
71	♀	9.2	4.8	5.6	3.0	(182)	185	1.47
L II	♀	6.2	3.4	3.8	1.4	(168)	175	0.61
M I	♀	12.4	8.8	7.6	6.0	(182)	192	0.96
67	♂	12.2	8.4	7.8	4.8	199	192	0.86
M II	♂	10.3	5.1	6.5	4.0	(182)	188	0.90
N I	♀	14.7	5.6	8.3	2.8	214	195	1.31
74	♀	10.4	3.1	7.2	1.6	200	190	0.60
N II	♂	12.4	3.2	6.2	2.5	214	190	0.95
O I	♀	13.8	5.0	8.5	3.0	202	195	1.18
61	♂	15.0	7.8	10.6	4.6	199	199	0.84
O II	♀	13.2	5.1	8.3	2.8	202	194	0.96
P I	♂	18.2	8.2	11.2	5.8	197	202	0.84
66	♂	19.6	11.2	11.2	6.1	201	203	1.22
P II	♂	16.6	8.6	10.8	5.4	197	200	0.68
Q I	♂	25.0	12.6	16.8	8.4	(210)	210	1.38
65	♂	20.8	6.2	10.0	6.0	(196)	200	1.20
Q II	♂	24.2	10.6	14.2	8.4	(210)	206	1.16
R I	♀	47.6	21.4	24.9	18.3	224	220	2.04
33	♀	40.1	22.2	19.0	19.1	229	215	2.59
R II	♂	36.2	17.7	18.5	8.1	224	216	1.94
S I	♂	62.4	34.4	36.2	19.0	280?	230	2.43
57	♀	48.2	29.9	26.1	18.2	258	231	2.75
S II	♂	48.8	25.6	28.4	17.4	280?	225	1.57

[1] Duration of gestation estimated from $28 (\log \underline{a} + \log \overline{a}) + 137$, the regression equation.
[2] Parentheses show ages recorded to the nearest week.

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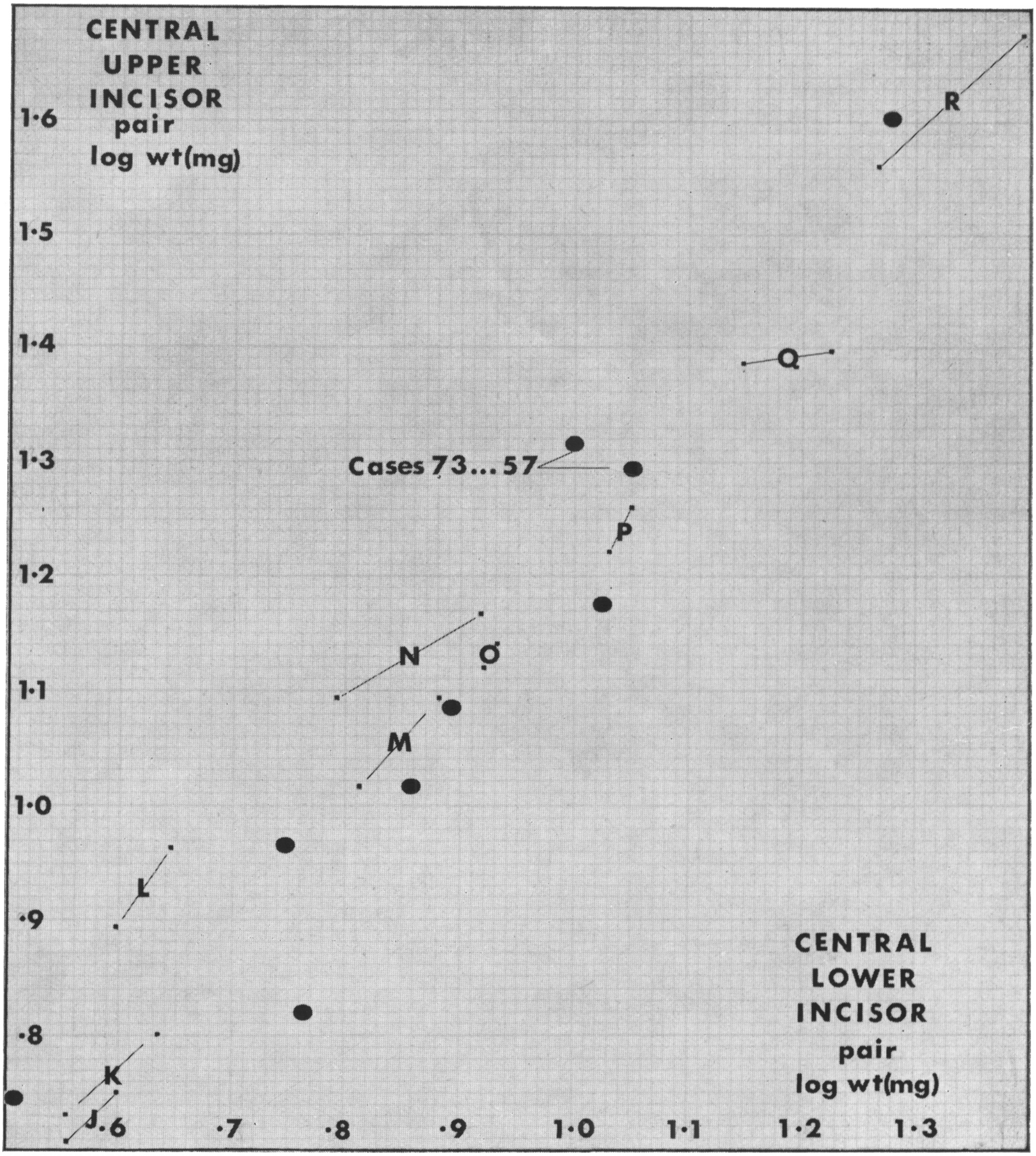

Fig. 1

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week. Body weights ranged from 0.5 to 2.75 kg., the upper limit being beyond the accepted level of prematurity (but this foetus was probably over weight since the records showed maternal diabetes).

An internal comparison involving ratios of tooth weights was considered to reduce the variability due to age differences. It was observed that the ratios of weights of pairs of incisors (lower: upper) increase with development, although this internal comparison is not markedly dependent upon age. This trend required suppression before subjecting the data to an analysis of variance. Several functions of weight were tested in order to establish the superiority of the use of logarithms as the means of expressing the weight data such that the ratios so transformed were least affected by age (Figure 1). This function was also suitable for use with the more variable lateral incisors (Table 2). Logarithmic transformation of data provides the basis for the study of differential growth, as used for example by Moss & Applebaum (1957), who applied the logarithmic function in comparing the dimensions of developing teeth.

Tab. 2. Logarithms of weights of pairs of lower incisors as percentages of logarithms of weights of pairs of upper incisors

Case no.	Sex	Central	lateral	Case no.	Sex	Central	lateral	Case no.	Sex	Central	lateral
J I	♂	81	85	M I	♀	81	82	Q I	♂	84	84
73	♂	68	—	67	♂	82	74	65	♂	76	98
J II	♂	79	80	M II	♂	80	85	Q II	♂	88	90
K I	♀	79	70	N I	♀	79	60	R I	♀	83	95
68	♀	93	74	74	♂	85	(41)	33	♀	79	90
K II	♀	76	78	N II	♂	73	78	R II	♂	81	73
L I	♀	67	(25)	O I	♀	82	68	S I	♂	83	78
71	♀	78	70	61	♂	88	74	57	♀	84	85
L II	♀	73	(38)	O II	♀	83	63	S II	♂	80	81
				P I	♂	83	84				
				66	♂	81	75				
				P II	♂	81	68				
				Z I		(43)	(14)	(Monozygotic twins, 28 weeks)			
				Z II		(44)	(13)				

J Immaturity	O Toxaemia [1]	73 Atelectasis	61 Immaturity
K Immaturity	P Atelectasis	68 Atelectasis	66 Atelectasis
L Haemorrhage [1]	Q Immaturity	71 Prematurity	65 Prematurity
M Atelectasis	R Toxaemia	67 Prematurity	33 Atelectasis
N Atelectasis	S Immaturity	74 Toxaemia [1]	57 Atelectasis

[1] Maternal factor. Other factors: maternal toxaemia (Case 33), haemorrhage (Case 66), diabetes (Case 57).

Table 2 lists the ratios of logarithms for both central and lateral incisor pairs from the data of *Table* 1. Group mean ratios fell within the range 0.78-0.81. The logarithmic form of the data precluded one comparison in Case 73 because the pair of lower lateral incisors weighed only 1 mg. The slight growth of teeth of this type as compared with the upper lateral in Case 74 and in the third pair of twins gave rise to ratios of logarithms which were less than one-half the mean.

With these exceptions, coefficients of variation in twins were 4% (central incisors) and 11% (lateral incisors); corresponding values in the other cases were 7% and 12%, respectively. Of the four mean intra-pair differences, those within pairs of twins were least for central incisors but greatest for lateral incisors. The Fisher variance ratio test was applied to the paired data in *Table* 2. Inter-pair differences were significantly greater than intra-pair differences ($P = 0.005$), but the other variance ratios tested were not significant. The inclusion in this Table of ratios for Case Z (monozygotic twins, foetal age 28 weeks) emphasises the relative deficiency of growth in the mandibular teeth.

The regression of age on central incisor (log) weights was next investigated, using the paired data (i.e. incisors from one of each pair of twins) as shown in *Table* 1. A correlation coefficient of 0.95 was first noted, and the regression equation for predicting foetal age in days from incisor weight data was

$$28\ (\log W_{\bar{a}} + \log W_{\underline{a}}) + 137$$

where $W_{\bar{a}}$ and $W_{\underline{a}}$ are weights of pairs of lower and upper central incisors. This equation was used in estimating durations of gestation in *Table* 1. Estimates of foetal ages of the twins and of the other cases differed from the recorded ages by five days, excluding the data on Twins N, where the discrepancy was as high as 3 weeks (the data were therefore omitted in evaluating the regression equation). Differences in dental growth status within pairs of twins were also expressed in terms of days. The mean difference was equivalent to four days' growth. It is to be expected that such differences would widen in twins of more advanced growth.

Table 3 records dimensions of incisors from the two most advanced pairs of twins and from two pairs of foetuses of similar maturity. Differences in mesiodistal width appeared less likely to account for the weight differences among the twins than crown height differences. Contrast in mesiodistal width and crown height is evident in Cases 103 and 107.

Discussion

The use of an allometric comparison is seen to allow an investigation of relative dental development in twins of differing dental growth status. The logarithmic differential growth function is suitable for the present system which involves growth at different rates. Ratios of lower and upper central incisor weights (log units) were 4 : 5, with a coefficient of variation of 4%. Growth rates in terms of square roots of tooth pair weights have been found to be in the ratio 8 : 11 over a longer period of growth than that covered by the present material.

Accepting that dimensions of central incisors become measurable at about the 14th week of gestation (Kraus, 1959), the differences in growth rate within pairs of twins amount to 3-4%, on the basis of tooth weights. This is of the same order as the mean differences between recorded and estimated ages. Inclusion of data for lateral incisors was not found to add to the precision of such estimates because these teeth are comparatively variable.

Foetuses delivered at term can frequently be presumed normal in growth when they fail to survive birth. But incisor growth has been studied in foetuses delivered

Tab. 3. Mesiodistal widths and crown heights of central incisors

Measurement (mm)			R I	R II	S I	S II	33	57	103	106
Upper	Left	MW	5.42	5.28	5.74	5.59	5.01	5.39	5.90	4.76
		CH	4.66	4.16	4.98	4.51	4.14	4.57	4.18	4.38
	Right	MW	5.48	5.28	5.71	5.56	5.03	5.41	5.80	4.72
		CH	4.60	5.14	4.95	4.50	4.18	4.56	4.18	4.42
Lower	Left	MW	3.58	3.42	4.06	3.81	3.07	3.60	3.96	3.50
		CH	3.96	3.52	4.29	3.70	3.90	4.26	3.50	3.88
	Right	MW	3.58	3.32	4.01	3.76	3.08	3.66	3.94	3.48
		CH	4.16	3.56	4.24	3.68	3.88	4.27	3.56	3.90
Sum MW			18.5	17.3	19.6	18.7	18.2	18.0	16.4	19.6
Sum MD			17.4	15.4	18.5	16.4	14.1	17.7	16.6	15.4

2-3 months earlier and their growth cannot be said with confidence to have been unimpeded. Atelectasis is frequently noted in pathological reports (Table 2) on foetuses at this stage. This condition of lung immaturity is not necessarily indicative of retardation in growth. It is more likely that growth will be delayed when there is placental inadequacy, as indicated by maternal histories of pre-eclamptic toxaemia or ante-partum haemorrhage (Stack, 1962). Assessments of duration of gestation from incisor weights differed from the recorded data by an average of only 4 days both in the twin group and in the cases selected for comparison with them, in those 12 instances where the pathological factors were confined to " immaturity " and " atelectasis " (excluding the data on twins N, where the discrepancy was as great as 3 weeks).

Early growth in mesiodistal width of central incisors may be compared with that seen in alizarin-stained jaws (Kraus, 1959). Means, given to the nearest 0.1 mm. on five groups of specimens were 2.2 mm. (lower) and 3.0 mm. (upper) at a mean crown-rump length of 143 mm., and 2.6 mm. (lower) and 3.8 mm. (upper) at crown-rump length 157 mm. These mean crown-rump lengths correspond to an age difference of about one week at the 17th-18th weeks of foetal life. Similar mean values for groups of five specimens from the present series, selecting from the twins and comparable foetuses, were 3.1 mm. (lower) and 4.7 mm. (upper) at the 25th week, 3.6 mm. (lower) and 5.7 mm. (upper) at the 27th week. The discrepancy may be due to variation in timing of early dental growth in different populations or to the methods of measurement.

Changes in shape predominate at the stage studied by Kraus. The simultaneous changes in size and shape, particularly in the upper central incisor, prevent extrapolation of the present regression equation towards very early stages in mineralization. Change in size alone is more characteristic of incisor crown development during the remainder of the foetal period. The regression equation is thus suitable for data within the ranges encountered (upper central incisor weights of 5-50 mg., lower central incisor weights of 3-30 mg.) but gives estimates of increasingly poor precision the further it is applied beyond the range.

One aspect of variability not evident from the tabulations of the data is the variation between right and left sides which has recently been discussed by Lysell, Magnusson & Thilander (1962) in relation to eruption. The mean weight difference between teeth on the two sides of the jaws was less than 3% for the central incisors. Weights were more often greater on the left side, but not significantly so. However, in the case of Twin P I, the incisors were 0.4 mg. heavier on the left side than on the right. This difference was only equivalent to a day's difference in growth. Weights of incisors were the same on the two sides in the other twin. It was noted from Table 3 that dimensions were more often greater on the left side than on the right, with a frequency ratio of 3 : 2, but this also was not significant.

Similar normality of dental growth was observed in seven gestations where one twin was lost (Table 4). Foetal ages were, in these cases, estimated from the formula 6 ($W^{1/2}$ + 25), where W is the sum of the weights of central and lateral incisors

Tab. 4. Recorded and estimated durations of gestation in twins

Pathology	Case no.	Duration of gestation (Days) Recorded	Duration of gestation (Days) Estimated	Body weight (kg.)
Injury	223	247	242	2.16
Injury	59	255	255	3.15
Cord insertion [1]	116	260	251	2.61
Pneumonia	122	265 + 10 [2]	262	1.97
Toxaemia [1]	137	272	280	2.46
Asphyxia	200	286	284	2.38
Asphyxia	247	289	289	3.03

[1] Maternal factors. [2] Equivalent to c. 270 days.

and first molars from both jaws (Stack, 1960). The estimate was 3-4 weeks low in another case where one of a set of triplets was lost, but the retardation in dental growth was sufficiently accounted for by maternal pre-eclamptic toxaemia and antepartum haemorrhage. Postnatal age was estimated as $5\frac{1}{2}$ weeks from the same types of teeth by a similar formula more suitable for estimating age during infancy — $1.6\,(W^{1/2} - 25)$ — in a twin lost from pneumonia 12 weeks after a $34\frac{1}{2}$-week gestation. These additional findings confirmed the supposition from the study of premature twins — that dental growth in twins is not significantly less than that in single births.

Summary

Weights of mineralized dental tissue have been determined in incisors dissected from ten pairs of twins failing to survive beyond 7-8 months' gestation. Logarithms of weights were compared as ratios (lower/upper) with data from foetuses of similar development. Intra-twin differences were thus shown to be significantly less than inter-twin differences when comparing central incisors. Lateral incisors were too variable to allow this demonstration. The linear regression equation combining logarithms of lower and upper central incisor weights was suitable for estimating foetal age to within one week of the recorded age.

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RIASSUNTO

Sono stati determinati per dissezione i pesi di tessuto dentario mineralizzato negli incisivi di 10 coppie di gemelli che non sono sopravvissuti oltre i 7-8 mesi di gravidanza. Sono poi stati raffrontati i logaritmi di questi pesi (proporzione tra gli inferiori e i superiori) con i dati di feti con sviluppo simile. Le differenze osservate tra i gemelli si sono rivelate significativamente meno importanti delle differenze riscontrate paragonando gli incisivi centrali di provenienza diversa. Gli incisivi laterali sono risultati troppo variabili per permettere tale constatazione. L'equazione di regresso lineare combinante i logaritmi dei pesi degli incisivi inferiori e di quelli superiori si è rivelata atta a calcolare l'età fetale con un'oscillazione di una settimana circa.

RÉSUMÉ

On a determiné par dissection les poids de tissu dentaire minéralisé dans les incisives provenant de dix paires de jeumeaux n'ayant pas survécu au-delà de 7 à 8 mois de gestation. On a comparé ensuite les logarithmes de ces poids comme proportion entre les inférieures et les supérieures avec les données provenant de foetus non-jumeaux à développement semblable. Les différences observées entre jumeaux se sont montrées beaucoup moins importantes que les différences observées lorsqu'on comparait les incisives centrales d'autre provenance. Les incisives latérales se montraient trop variables pour permettre cette constatation. L'équation de régression linéaire combinant les logarithmes des poids des incisives inférieures et supérieures s'est montrée propre à determiner l'âge foetal à une semaine près de l'âge établi.

ZUSAMMENFASSUNG

Die Gewichte der mineralisierten Zahngewebe der Schneidezähne wurde von Zwillingspaaren untersucht, die den 7-8 Monat der Gestation nicht überstanden. Die Gewichtslogaritmen wurden als Verhältnisse (unteren/oberen) mit Daten von almlichen Foeti verglichen. Intra-Zwillinge zeigten weniger Verscheidenreiten wie Inter-Zwillinge. Laterale Schneidezähne waren zu unterschiedlich um irgendetwas zu beweisen. Die Logaritmen des Gewichts der unteren und oberen Schneidezähne erlaubten das Alter des Foetus bis auf eine Woche genau zu bestimmen.