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Tooth eruption symmetry in functional lateralities

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Abstract

Dental casts and oral photographs from a cross-sectional sample of 2092 young North Americans with detailed information on functional lateralities (eyedness, handedness and footedness) were examined to compare the proportions of symmetrical and asymmetrical eruption of the antimeric (left–right, contralateral pair) permanent teeth using a four-grade eruption scale. The proportion of symmetrically erupting antimeric teeth was higher for some teeth in those with non-right-sidedness of the feet and eyes, but not significantly so in the case of handedness. Left-footedness was significantly (95% confidence interval) associated with an increased proportion of symmetrical pairs of the maxillary first molar and mandibular lateral incisor, and non-right-eyedness with an increased proportion of symmetrical eruption and left/right non-balanced proportions of asymmetrical eruption in maxillary central incisors. True right-sidedness (hand, foot and eye) was significantly ($P \leqslant 0.05$) associated with advanced eruption of the left mandibular first molar. It is suggested that while the timing of antimeric tooth emergence and clinical eruption is primarily programmed before crown mineralization, starting approximately at the 30th gestational week in the case of first permanent molars, symmetrical/asymmetrical tooth emergence and eruption may provide information a posteriori on prenatal and early postnatal growth and development.

Keywords: Fluctuating and directional asymmetry; Human dental development; Left–right dominance; Unilateral maturation

1. Introduction

Clinically is very common to see contralateral differences in antimeric tooth emergence. One- to 6-month differences between the left- and right-hand sides are normal and usually there is no great harm to the structural or functional development of the child's dentition. Eruption symmetry has not been examined extensively in population studies and only a few of the comparisons of contralateral tooth eruption have emphasized on directional/fluctuating contralateral differences. According to Steggerda and Hill (1942), Tomes (1859) believed that teeth on the left-hand side erupt earlier, while Bean (1914) was of the opinion that some teeth erupt earlier on the left- and others on the right-hand side; Cattel (1928) attempted to verify these facts, but found such asymmetry only in the maxillary first premolar (references in Steggerda and Hill). Although the left–right dental asymmetry was later regarded as random (fluctuating), it has been suggested that both dimensional (crown size) asymmetry and temporal (eruption) asymmetry might be structured (Garn et al., 1981). Symmetry and asymmetries in antimeric tooth eruption were shown to be sex- and race-specific in a

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study by Heikkinen et al. (1999), where girls were more symmetrical than boys in the eruption of incisors, canines and maxillary first premolars, Afro-Americans were more symmetrical than caucasoids in mandibular incisors and canines, and directional asymmetry appeared as a right-side advantage in the eruption of the upper first premolar in Afro-American boys.

The processes that cause a tooth to emerge from its crypt and to erupt through the gum are only partly understood in spite of the wide research in this area (Davidovitch, 1994; Davidovitch et al., 1998). Despite the fact that genetic factors appear in the differential timing of mean tooth emergence between sex and race groups, tooth eruption is multifactorial, including local controlling factors (crowding, premature or delayed loss of deciduous teeth), secular trends and social background. As early as 1969, Friedlender and Bailit suggested that their findings could be interpreted as pointing to an early susceptible stage in tooth development after which most influences cease to have any effect. This critical stage probably occurs prenatally in those teeth in which mineralization commences before or soon after birth, i.e., the first molars and permanent incisors. In permanent canines and first premolars this critical stage probably occurs during the first postnatal years, and in second molars and premolars 2 or 3 years later. Other important later stages and mechanisms regulating tooth eruption, including those involved in the continuous blood supply, the growth of the periodontal ligament, alveolar bone and the nerves of the tooth, cannot be overruled. Recently, the dental follicle has been a major focus in tooth eruption studies, e.g in early alveolar eruption of the tooth (Cahill and Marks, 1980), and cascades of signalling molecules and other substances have been discovered to accelerate tooth eruption during intra-alveolar bone resorption /apposition (Wise, 1998; Wise et al., 1994).

Human laterality has been shrouded in myth since the beginning of history, and handedness, for example, has been held to be multifactorial in origin. Sex difference has been observed in many traits expressing laterality, with females exhibiting more symmetry, but any such differences are too small to be classed as sexual dimorphism (Morgan, 1980). The main themes of research in human structural and functional laterality, including handedness, footedness and eyedness, have had genetic, environmental, social, psychological, neurophysiological and anatomical perspectives. In general, a strong current towards a genetic background in human laterality exists (Annett, 1981) and the conclusions of reviews, such as those of Corballis (1983) and Geschwind and Galaburda (1985), focus on the largely unknown role of gestational development in determining human laterality, and cite as an example the many entodermal structures that are more asymmetrical than tissues of ectodermal or mesodermal origin. Left-cerebral dominance exists for the human-specific skills, such as language, and the right hemisphere is more active during emotion; facial movements, for example, are better controlled on the left-side of the face, which means a simultaneous increase in the activity of the right hemisphere (Chaurasia and Goswami, 1975). It is not well documented whether these associations between nervous and functional systems could be genetic or environmental, forming a determined basis for the start of the function, or later, developing during the 'training' period.

The teeth provide a useful instrument for the study of development due to their unique structure and long period of sequential development. We have suggested in earlier papers that the association of some gestational and postnatal variables, such as maternal smoking during pregnancy and affected motor development in infancy, are involved in the reduction of crown dimensions in some deciduous and permanent teeth and an accelerated eruption of mandibular incisors (Heikkinen, 1996, 1998; Heikkinen et al., 1995, 1997). With the exception of second premolars and third molars the effects of maternal smoking on the permanent dentition of the child could be based on the sensitive period of crown development reaching from the middle gestation until birth, when most of the permanent teeth in sequence have began their development. Nicotine, for example, is a classic cholinergic agonist and may have differential effects on the left- and right-hand sides of developing neural system (Domino, 1995). Prenatal exposure to tobacco smoke has been shown to increase fluctuating permanent tooth crown asymmetry (Kieser and Groeneveld, 1998). The sensitivity of each tooth in terms of size reduction, crown morphogenesis, asymmetry of antimeres, as well as that of the fetus during gestation, is associated with the sex and the race of the child, and with buffering mechanisms, such as the size of the fetus during critically sensitive moments of development (Heikkinen 1996).

Our aims now were first to explore the symmetry and the asymmetries of tooth eruption in functional lateralities, and second to elucidate the role of tooth eruption sequences as an indicator in the timing of overall laterality.

2. Material and methods

The study was made on 2092 children from the approx. 60 000 pregnancies that comprised the Collaborative Perinatal Study of the National Institute of Neurological Disorders and Stroke (NINDS) carried out in the 1960s. The dental examinations were performed at six of the collaborating medical centres (Buffalo NY, Richmond VA, Portland OE, Philadelphia PA, Providence RI and Johns Hopkins MD) in the early 1970s in a cross-sectional manner at ages varying in 95% of cases from 6.9 to 12.7 years. Mean ages in years at the time of the dental examination (casts and photographs) were 7.9 for caucasoid boys, 7.8 for girls, 8.9 for Afro-American boys and 9.3 for girls, facilitating the comparison of representative numbers of erupting permanent incisors, first molars, canines, premolars and second molars.

At each cooperating institution, alginate impressions were taken and normal dental plaster casts made as soon as practicable. Casts were checked and compared with oral photographs taken of every child in the study. Teeth with heavy attrition, decay, restorations, orthodontic appliances etc. were not studied. Neurological and other medical background data were obtained from the records from the moment of the first registration of the pregnancy (Niswander et al. 1972), i.e., during the first and second trimesters, up to child's seventh year of age. Carefully performed examinations of eye, hand and leg laterality were recorded at each centre according to uniform instructions used in the Collaborative Perinatal Study. The tests evaluated gross and fine motor skills, behaviour profile, and psychological and physical characteristics. Hand preference was evaluated by placing coloured pencils directly in front of the child, who was asked to make an 'X' on a piece of paper with each pencil. If the same hand was not used with each of the three pencils the test was repeated twice more. Any preference of less than four out of five was coded indetermined. Eye preference was detected by asking the child to look through a kaleidoscope, the experimenter noting which eye was used, and foot preference by placing a ball in front of the child and asking them to kick it three times, with each trial made after establishing a stable initial standing position. The experimenter noted whether there was a consistent preference in three trials. If two right and one left (or vice versa) responses were obtained, two more trials were made and any preference of fewer than four out of five was coded as indetermined. Patterns of lateral preferences, interrelationships, sex and race differences in functional lateralities etc. in Collaborative Perinatal Study children are discussed elsewhere (Nachshon et al., 1983).

The eruption of permanent teeth was determined from normal dental casts by one observer (L.A.), a member of the Genetic-Odontometric Study team at the University of Wisconsin (1972–1974). Within each child the tooth antimeres were compared in terms of a four-grade eruption scale, each tooth separately. The eruption stages were: 0, tooth not erupted; 1, occlusal surface of tooth recently emerged; 2, tooth crown half erupted; 3, eruption of tooth complete or nearly complete. This part of the lifetime clinical eruption for each tooth lasts 6–12 months. Each of these stages during this period is easily distinguishable clinically by an experienced observer. The reliability of staging was determined by performing duplicate blind determination on 200 cases. Interobserver reproducibility of the stages (T.H.) was moderately good, with an average of 85%. The greatest error, 24% of the cases, occurred between the determinations of stage 2 and stage 3 in the maxillary molars.

When forming the antimeric pairs on dental casts, the total data were used in order to reach the maximum number of pairs in spite of the fact that occasionally different teeth can be unilaterally missing in varying proportions, but in this series it was not possible to ascertain hypodontia by using radiographs. To avoid bias a solid criterion was that the pair, being either a symmetrical or asymmetrical pair of contralateral teeth, must have had at least one of the teeth in the active eruption phase (stages 1 and 2) to be included in comparisons, asymmetrical pairs being constructed from the teeth in stages 0–3 and symmetrical ones from teeth in stages 1 and 2 (Fig. 1). Casts showing multiple erupting teeth were few (maximum six tooth pairs in two cases), and those were accepted in spite of the presence of the same person repeatedly in comparisons.

The proportions from the trinomic distribution of antimeric tooth pairs that were right-advanced, left-advanced or equal in terms of eruption stage were calculated in each tooth. In each functional category (handedness, footedness and eyedness; Tables 1 and 2) the three types (right-dominant, left-dominant and indetermined) were compared statistically first testing the hypotheses of trinomic dental equality in these groups

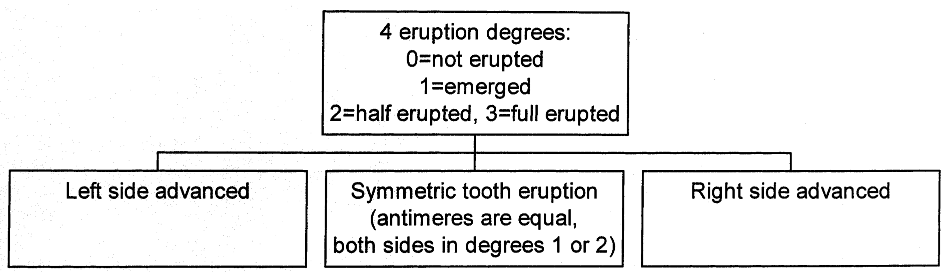

Fig. 1. The symmetry and asymmetry of antimeric teeth in the permanent dentition; method of investigation on dental casts.

Table 1
The proportions of right-, left- and indetermined (Indeterm.) eyedness, handedness and footedness at 4 years of age in Collaborative Perinatal Study children

	Right (%)	Left (%)	Indeterm. (%)	Total (n)	(%)
Eyedness	54	41	5	1819	(100)
Handedness	78	8	14	1836	(100)
Footedness	83	12	5	1813	(100)

using 3×3 tables and χ^2 statistics. Cells with n fewer than five were excluded. Functionally indetermined cases were not included in the results in Figs. 2–4, due to the considerably large amount of data on functionally right/left-determined cases.

Right-sidedness was compared with non-right-sidedness in general using the combinants constructed from all three functional categories; children with a complete set of right-handedness, right-footedness and right-eyedness (RRR, $n = 742$; Table 2) were compared with all other combinations ($n = 1091$; Table 2) by testing the equality of the dental symmetry/asymmetry proportions (2×3 tables and χ^2 tests). Binomic frequencies for asymmetrical cases, either right- or left-advanced in eruption, were tested using a binomic test, and 95% confidence intervals were calculated for the equality of proportions in symmetrical tooth pairs. P-values of less than 0.05 were taken as significant.

The laterality of the tooth eruption (Fig. 5) was calculated from the% sum of left- or right-advanced asymmetrically erupting pairs, the total number from the binomic distribution ($n\mathrm{R} + n\mathrm{L}$), with the left-advanced being negative and right-advanced being positive % values. In tables and figures the teeth are placed into the common emergence order calculated from the mean age of the children in months during stage 2, i.e., during tooth emergence. Tooth-emergence order is also thought to serve as a model for the unknown developmental order of teeth during early sensitive crown-formation stages, which probably involve the timing of tooth emergence programming. However, in each tooth and between different teeth the length of the sensitive period may vary greatly and also simultaneous timing may occur. There are also obvious sex and race differences between means and SD for the timing of the tooth emergence and for earlier emergence programming (Harris and McKee, 1990; Hurme, 1949; Moorrees et al., 1963; Nanda, 1960; Sofaer et al., 1971; Steggerda and Hill, 1942). Emergence differences were calculated in general, and in terms of symmetry, according to this method in each tooth in both the caucasoid and Afro-American children, boys and girls separately, in earlier papers (Heikkinen et al., 1995, 1999).

3. Results

In Table 3, where all tooth pairs are present in two trinomic distributions, which are true functional right-sidedness (RRR) and other combinations expressing mixed non-right-sidedness (RRL, RLL, LLL, RRI, RLI etc.; Table 2) in varying magnitudes, the mean proportion of symmetrically erupting antimeric pairs is equal to 95% in first-erupting mandibular incisors, while the maxillary lateral incisors, which are the last teeth of the first phase of mixed dentition, had this proportion in 47%. Further, according to the tooth eruption sequence this proportion is decreasing, being only about 5% in second premolars. The last-erupting permanent teeth in the second phase of mixed dentition were greatly symmetrical, upper canines 42% and second molars 70%.

Emphasis was placed on the relative proportion of symmetrical pairs between true right-sided and 'mixed' individuals as well as on the similarity of left- and right-sided advanced tooth eruption in both groups separately, and between them. The greatest χ^2 values (which were statistically non-significant, however) appeared on both ends of the total eruption sequence for the clinical emergence of the permanent dentition. A statistically significant difference ($P < 0.05$) appeared in the mandibular first molar, which had an unbalanced

Table 2
Various combinations in determined and indetermined (Indet.) functional lateralities at the age of 4 years in the Collaborative Perinatal Study; number of cases

Eyedness	Handedness	Footedness		
		Right	Left	Indet.
Right	Right	742	43	27
	Left	20	31	3
	Indet.	101	18	8
Left	Right	474	41	26
	Left	28	41	5
	Indet.	90	28	10
Indet.	Right	59	7	3
	Left	4	7	0
	Indet.	9	3	5

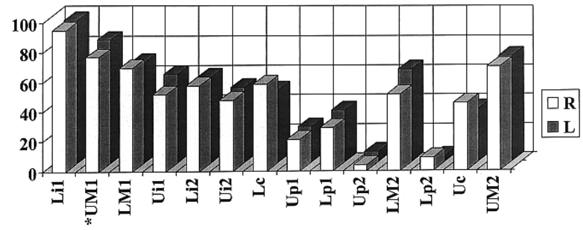

Fig. 2. The proportion (%) of symmetrical eruption of antimeric teeth in right (R)- vs left (L)-sided eyedness; * statistically significant difference (UM1 95% CI: − 12.0, 0.0).

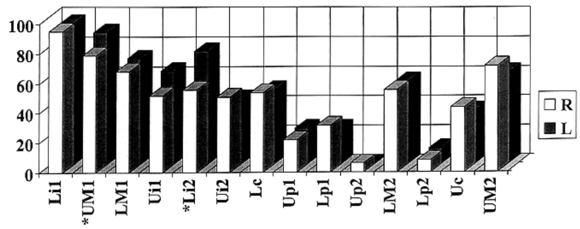

Fig. 4. The proportion (%) of symmetrical eruption of antimeric teeth in right (R)- vs left (L)-sided footedness; * statistically significant difference (UM1 95% CI: − 17.0, − 1.6; Li2 95% CI: − 33.0, -5.8).

asymmetrical proportion in the RRR group (Table 3; Fig. 5).

When the emphasis was placed on each functional laterality, there were significant differences in the proportion of dentally symmetrical cases between right-sided and left-sided individuals (Figs. 2–4). In this arrangement, the number of right/left-advanced tooth pairs remained too low for meaningful statistical comparisons in most cases, but the relative number of symmetrically erupting teeth was explored using confidence intervals (95%). In eyedness, the symmetrical proportion of upper first molars appeared significantly greater in left-eyed individuals than in right-eyed (Fig. 2), and the eruption of the upper central incisor varied significantly ($P < 0.03$), also showing unbalanced proportions in asymmetrical tooth eruption: the left-eyed had the maxillary left central incisor advanced in less than 15%, while the right incisor was advanced in more than 25% of cases. Those with indetermined eyedness had the left incisor advanced in more than 38% (right incisor in 15%) of cases, while an increased proportion (60%) of symmetrical maxillary central incisor eruption was associated with left-eyedness, compared to 52% in right-eyedness and 46% in indetermined eyedness (Table 4).

Statistically significant differences appeared also in footedness, where the left-footed had significantly more (95% confidence interval) symmetrical pairs in maxillary first molars (89 vs. 79%) and mandibular lateral incisors (76 vs. 56%), than the right-footed (Fig. 4). In handedness the differences were insignificant and the proportions were difficult to compare due to the relatively small number of left-handed children (Fig. 3 and Table 1).

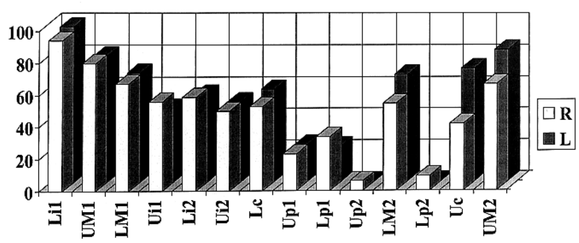

Fig. 3. The proportion (%) of symmetrical eruption of antimeric teeth in right (R)- vs left (L)-sided handedness.

In Fig. 5, the binomic proportions of asymmetrically erupting antimeric pairs are presented as a sum of percentages, where left-advanced are negative ($-$%) and right-advanced positive ($+$%) values. It appears that left-advanced appeared at the beginning (M1, $p(\text{bin}) \leq 0.05$ in true right-sided children) and at the end (upper M2 and upper C) of the mixed dentition, while most of the other teeth were right-advanced. Sex and ethnic differences are presented in an earlier paper (Heikkinen et al., 1999).

4. Discussion

The results suggest first that children having non-right-sidedness in functional lateralities have slightly increased symmetrical proportions in antimeric first molar and lateral incisor eruption compared to true right-sided children, in footedness and eyedness more than in handedness; and secondly that different teeth express the symmetrical/asymmetrical proportions of antimeric pairs in a specific manner, associated with non-right-sidedness in functional preferences. We have earlier shown sex and ethnic differences in the patterns of advanced eruption between left and right in first and second phases of mixed dentition (mandibular incisors, canines, premolars and maxillary first premolars); thus genetic background factors should be taken into consideration in comparisons. In functional lateralities no significant sex or ethnic differences appeared in hand, eye and foot left–right preferences in Philadelphian Collaborative Perinatal Study children (Nachshon et al., (1983).

Supporting evidence exists for alternative hypotheses on the aetiology of lateral preferences, namely genetic, environmental and intermediate (Annett, 1973; Collins, 1977; Dawson, 1977). It has been suggested that a ‘shift’ or a gradient from left to right exists, probably

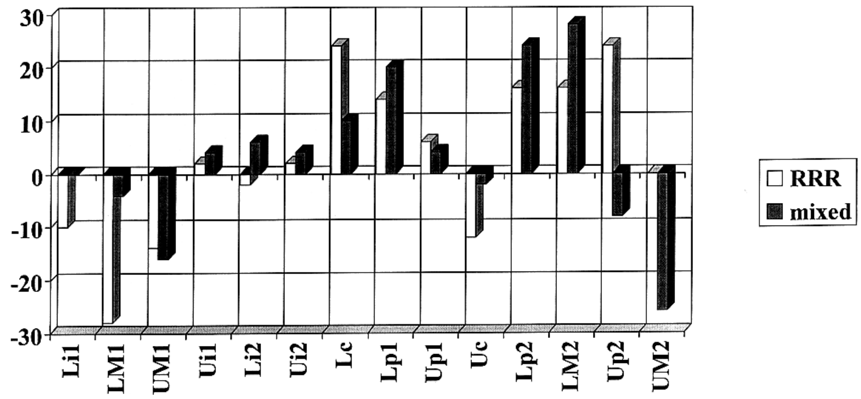

Fig. 5. The relative proportions of left (− %)- and right (+ %)-advanced tooth antimeres in functional total right-sidedness (RRR) vs mixed non-right-sidedness calculated from the binomic distribution of asymmetrical eruption. LM1(RRR) $p(\text{bin}) \leq 0.05$.

providing the raw material out of which the hemispherical laterality of brain function develops (Corballis and Morgan, 1978; Geschwind and Galaburda, 1985). This developmental laterality of the left- and right-hand sides has been seen to be continuous in fetal life and the cyclic changes could continue after birth and throughout development (by Mittwoch, in commentaries to Corballis and Morgan, 1978, pp. 306–307; Thatcher et al., 1987). Annett (1981) proposed that, in a minority of the human population, the common lateralizing influence, 'right shift', is absent or a weak manifestation, perhaps because of the presence of a recessive genetic allele. Among this minority, different manifestations of laterality are dictated independently and at random. The great majority of right-handers are right-footed and right-eyed and they have their language and praxic skills represented in the left cerebral hemisphere, whereas left-handers show much more varied and unpredictable patterns of asymmetry, have less anatomical symmetry in the brain, testes and skin (Geschwind and Galaburda, 1985). Another way to express this is to say that the left-handers are not so well buffered against environmental influences (Corballis, 1983; Waddington, 1957).

Observing variation in the symmetry patterns of tooth eruption may give new perspectives for developmental studies in dentistry as well as in other fields of medicine. Our earlier and recent results suggest that asymmetrical tooth eruption is not only fluctuating from one side to another, but may be reminiscent of

Table 3
The number of contralateral tooth pairs and the trinomic proportions of asymmetric and symmetric pairs in functional total right-sidedness (eye-right, hand-right, foot-right, RRR, $n = 742$) and in mixed combinations ($n = 1091$)[a]

Emergence order	Left side advanced		Symmetric eruption		Right advanced				Asymmetry p(bin)	
	n_{RRR}	n_{mix}	n_{RRR}	n_{mix}	n_{RRR}	n_{mix}	χ^2	p	RRR	mix
Li1	11	9	278	432	9	9	2.83	0.24	0.66	1.0
LM1	30	35	113	128	17	32	2.48	0.29	0.05*	0.16
UM1	35	43	203	351	27	31	3.73	0.15	0.31	0.16
Uil	32	53	86	133	34	58	0.17	0.92	0.80	0.63
Li2	37	53	98	162	36	59	0.35	0.84	0.90	0.57
Ui2	39	47	72	100	40	51	0.31	0.86	0.91	0.68
Lc	13	27	44	67	21	33	0.66	0.72	0.17	0.44
Lpl	15	22	16	25	20	33	0.07	0.96	0.40	0.14
Up1	24	30	14	18	27	32	0.04	0.98	0.67	0.80
Uc	13	21	18	30	10	20	0.19	0.91	0.54	0.87
Lp2	13	14	4	2	18	23	1.10	0.58	0.37	0.14
LM2	11	8	24	39	15	14	3.02	0.22	0.44	0.21
Up2	14	22	2	3	23	19	2.07	0.36	0.14	0.64
UM2	11	17	45	67	11	10	1.16	0.56	1.0	0.18

[a] *Abbreviations*: Li1, lower first incisor; UMi, upper first molar; Lc, lower canine; Up2, upper second premolar etc.

Table 4
The proportions of symmetrically and asymmetrically erupting antimeric pairs of upper central incisor in determined and indetermined (Indet.) eyedness[a]

	Left i1 advanced (%)	Symmetric i1 eruption (%)	Right i1 advanced (%)	n_{tot}
Right eyed	24.5	52.3	23.2	216
Left eyed	14.4	60.0	25.6	160
Indet. eyedness	38.5	46.2	15.3	26

[a] $\chi^2 = 10.6$, $p =$ value 0.03.

earlier observations in the central nervous system suggesting unidirectional maturational gradients (Corballis and Morgan, 1978; Thatcher et al., 1987), which are characterized here by a long-term shift from left to right in RRR children during the early mineralization of M1 and incisor crown (from 30th gestational week), and later from right back to left in the case of upper (but not mandibular!) canine and second premolars and molars (Fig. 5), which probably have their most sensitive phase for future eruption some years later (Friedlaender and Bailit, 1969; Heikkinen et al., 1999). Thatcher et al. (1987), for example, maintain that human cerebral hemispheres develop at different rates postnatally, which are chronologically comparable to ‘stages’ in perceptual, cognitive development.

Dental asymmetries, resulting from differences in the metric dimensions and in the morphology of antimeric teeth, have been used to estimate the effects of genetic or environmental disturbances on developmental homeostasis (Di Bennardo and Bailit, 1978; Mayhall and Saunders, 1986; Osborne et al., 1958; Perzigian, 1977; Siegel and Mooney, 1987; Sofaer et al., 1971). The asymmetry of tooth dimensions is said to be in general randomly distributed with respect to side, being generally called fluctuating asymmetry, and it is a common finding, for example, in Down’s syndrome (Barden, 1980; Townsend, 1983). Random discrepancies may indicate an inability of the individual to buffer against developmental disturbances or developmental ‘noise’, and an increased sample size seems to have profound effects on negating the existence of fluctuating asymmetry in statistical comparisons, as shown by Smith et al. (1982), who used the same Collaborative Perinatal Study data in their calculations. The evidence from directional size asymmetry in the dentition is not clear, but there are reports of differences between earlier and later developing dentitions in this sense, deciduous teeth being more directional (Hershkovitz et al., 1987). Tooth developmental order may vary greatly between individuals, as the order of emergence and mineralization in sex and ethnic groups varies (Harris and McKee, 1990; Hurme, 1949; Moorrees et al., 1963; Nanda, 1960; Sofaer et al., 1971; Steggerda and Hill, 1942). According to a traditional twin study by Hatton (1950) for example, determinants of tooth eruption timing in general are more genetic than environmental. The use of twins in the study of genetic/environmental effects is, however, under debate (Lauweryns et al., 1993), and the number of twins ($n = 200$) in our sample indicated a different approach, due to their suspected extra symmetry in some dental metric dimensions (Boklage, 1987). However, our results for eruption comparisons were the same with or without twins.

Laterality seems to be stronger in hands and feet than eyes and, for example, chewing function (Hoogmartens and Caubergh 1987; Nachshon et al., 1983). It is interesting that the eruption of the upper central incisor and the laterality of eyedness are associated (Table 4). It should be noted here that upper incisors are products of oral epithelium and ectomesenchyme, originating from the frontonasal area of the embryonal face, the area between the developing eyes. We have found in our material that some of the functional disorders of the eye, such as strabismus for example, might be associated with the variation in size, morphology and eruption of the upper incisors, and lateralities of tooth eruption with some unilateral malocclusions, which are matters for future research. In spite of the fact that tooth development is a highly isolated and autonomous process, tooth eruption among other dental variables might be influenced by other developmental systems, such as the neural, vascular or skeletal, parts of which are reminiscent of the early embryonal ancestry in the head area. Here, tooth eruption asymmetry may give a description of long-term developmental instability between the right- and left-hand sides originating from several phases of development. These range between the embryonal, fetal and postnatal, and the result seems to be involved with genetic and epigenetic factors, which are different between individuals varying in the functional lateralities, and between different teeth, showing differential sensitivity to proportionally increasing environmental factors during odontogenesis (Barden, 1980; Dahlberg, 1945; Garn et al., 1966).

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