SCIENTIFIC ARTICLE

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New standards for permanent tooth emergence in Australian children

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Abstract

Background: Published standards for permanent tooth emergence in Australian children are 40 years old. The aim of this study was to present new data on the timing and sequence of permanent tooth emergence in a large sample of Australian children and to compare the findings with those of earlier studies.

Methods: Records of a randomly selected sample of 8676 children, aged between 4 to 16 years, who had attended the clinics of the South Australian Dental Service were scanned optically and coded to provide the data for this study. A logistic regression analysis enabled median times of emergence, together with percentile ranges, to be calculated for each tooth, except third molars, in boys and girls. Comparisons were made between the sexes and with previously published values. The frequencies of occurrence of emergence polymorphisms for different tooth pairs were also computed.

Results: The earliest teeth to emerge in both boys and girls were the central incisors and first molars, whereas the second premolars and molars and maxillary canines tended to be last to emerge. The mandibular teeth tended to precede the corresponding maxillary teeth in emergence in both sexes. Tooth emergence was advanced in girls compared with boys, averaging 4.5 months in the maxilla and 5.3 months in the mandible. In general, emergence times of children in the present sample were later than those reported previously for Australian children. The most common emergence polymorphism in the maxilla involved the canine and second premolar, whereas common polymorphisms in the mandible were noted for the central incisor and first molar, canine and first premolar, and the second premolar and second molar.

Conclusions: Given that they have been collected relatively recently from a large sample of children, the new data reported in this paper can now be used as standards when assessing permanent tooth emergence of Australian children.

Key words: Dental development, eruption, sequence polymorphisms, sex differences.

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INTRODUCTION

Up-to-date population-specific standards on the timing and sequence of emergence of the permanent teeth represent an important resource for general dental practitioners, dental auxiliaries and specialists involved in managing dental problems in growing children. The data on tooth emergence in Western Australian children and for children in Canberra are now 40 years old.[1-2] Brown[3] subsequently provided tooth emergence data for indigenous Australians from Yuendumu in the Northern Territory but no recently-compiled standards for non-indigenous Australian children are available. Given the changing composition of the Australian community over the past four decades, the improvements in oral health, and the reported secular trends that have occurred in physical growth and development, it is appropriate that new standards for permanent tooth emergence in boys and girls are provided.[4]

Therefore, the aim of this study was to present new data on the timing and sequence of permanent tooth emergence in a large sample of Australian children and to compare these findings with the results of earlier studies.

MATERIALS AND METHODS

The data used for this study were collected as part of an investigation of the association between agenesis of the permanent first molars and emergence of the other permanent teeth.[5] A randomly selected sample of 8676 children comprising 4476 boys and 4200 girls aged four to 16 years provided data for the study. These children represented approximately one-fifth of the total attendees at South Australian Dental Service (SADS) clinics during 1988. Examination sheets for the children were scanned optically and then the data representing date of examination, sex, age, and whether each of the permanent teeth was present or absent were coded for subsequent statistical analysis. A tooth was deemed to be present if any part of the crown was visible in the mouth at the time of the examination. The majority of the children were most likely to be of European ancestry based on their names. Apart from the 4- and 5-year-olds, each of the yearly age groups from 6-16 years included over 500 children.

Table 1. Median emergence times (years) for permanent teeth in Australian children, including 5th and 95th percentiles

Tooth		Median	5th percentile	95th percentile
Males				
Maxillary	1	7.43	5.79	9.06
	2	8.61	6.36	10.86
	3	11.81	9.46	14.15
	4	11.28	8.94	13.62
	5	12.05	9.67	14.43
	6	6.71	5.05	8.37
	7	12.68	10.28	15.08
Mandibular	1	6.63	4.96	8.29
	2	7.77	5.97	9.58
	3	11.02	8.94	13.10
	4	11.15	9.01	13.29
	5	12.11	9.68	14.54
	6	6.63	4.96	8.30
	7	12.15	9.83	14.48
Females				
Maxillary	1	7.17	5.64	8.69
	2	8.24	5.99	10.49
	3	11.23	8.80	13.65
	4	10.77	8.58	12.96
	5	11.67	9.17	14.17
	6	6.57	4.84	8.30
	7	12.30	9.90	14.70
Mandibular	1	6.38	4.77	7.99
	2	7.47	5.67	9.28
	3	10.11	8.03	12.20
	4	10.59	8.45	12.73
	5	11.66	9.11	14.22
	6	6.42	4.86	7.98
	7	11.75	9.42	14.07

A logistic regression analysis was performed using Biomedical Data Processing (BMDP) software enabling median times of emergence and percentiles to be calculated for each tooth, except the third molars, in both boys and girls.[6] In addition, analyses were performed to determine the occurrence of present-present, absent-absent, present-absent and absent-present categories for all possible intra-arch tooth pairs at the time of examination of each individual. From these calculations it was possible to compute the frequency of occurrence of emergence polymorphisms for different pairs of teeth: for example, the percentage of children in whom the mandibular central incisor emerged before the mandibular first molar.

RESULTS

The median ages of emergence for all of the permanent teeth, excluding third molars, in boys and girls are provided in Table 1. In addition, the 5th and 95th percentiles are given, indicating the range within which 90 per cent of values within the sample fell. As there were no systematic differences in emergence times between sides, data are provided for the right side only.

The earliest teeth to emerge in both boys and girls were the central incisors and first molars, whereas the second premolars and molars and the maxillary canines tended to be last to emerge. The tooth emergence sequences within each arch were the same for boys and girls. In the maxilla, the following sequence was noted: first molar, followed by central incisor, lateral incisor, first premolar, canine and second premolar, then second molar. In the mandible, the order was: first molar and central incisor, followed by lateral incisor, then canine and first premolar, followed by second premolar and second molar.

Table 2. Comparison of median emergence times for permanent teeth in three Australian studies

		Halikas[1]		Carr[2]		Present study	
Tooth		Males	Females	Males	Females	Males	Females
Max	1	7.4	6.8	7.3	6.8	7.4	7.2
	2	8.1	7.6	8.5	7.9	8.6	8.2
	3	11.5	10.7	11.3	10.9	11.8	11.2
	4	10.3	9.9	10.5	10.3	11.3	10.8
	5	10.9	10.5	11.1	10.8	12.1	11.7
	6	6.3	6.4	6.5	6.2	6.7	6.6
	7	12.0	11.6	12.1	11.7	12.7	12.3
Mand	1	6.3	6.0	6.4	6.1	6.6	6.4
	2	7.6	8.2	7.5	7.2	7.8	7.5
	3	10.7	9.2	10.6	9.8	11.0	10.1
	4	11.3	10.4	10.9	10.4	11.2	10.6
	5	12.2	11.5	11.5	11.2	12.1	11.7
	6	6.2	5.9	6.4	6.2	6.6	6.4
	7	11.7	11.4	12.0	11.4	12.2	11.8

The mandibular teeth tended to precede the corresponding maxillary teeth in emergence in both sexes. An exception was the second premolar in males, although the difference in timing between these maxillary and mandibular teeth was small.

Australian girls were clearly advanced in their permanent tooth emergence compared with boys, averaging 4.5 months in the maxilla and 5.3 months in the mandible. The maxillary first molar showed the smallest difference in emergence timing between the sexes, with girls being advanced by only 1.7 months on average. The greatest difference in timing was shown by the mandibular canine which emerged 10.9 months earlier on average in girls.

In general, the emergence times of children in the present sample tended to be later than those reported by Halikis[1] and Carr.[2] The delays in median times of emergence ranged from a few months for some teeth up to a year for the maxillary first and second premolars (Table 2).

Frequencies of occurrence of the different tooth emergence polymorphisms in boys and girls are presented in the form of matrices in Fig 1. Sequences occurring in less than 5 per cent of the sample were considered to be rare, whereas those occurring more often were considered to be polymorphic. Following the approach adopted by Holly Smith and Garn,[7] results are presented to the nearest whole percentage to minimize the possible distracting effect of extremely rare sequences that resulted most probably due to recording errors at the time of the original examinations.

No published data about emergence polymorphisms appear to be available for Australian children so it was

Males – Maxilla

	M_1	I_1	C	P_1	C	P_2	M_2
M_1		(687) 92	(1478) 99	(3372) 100	(3766) 100	(3916) 100	(4409) 100
I_1	8		(887) 99	(2800) 100	(3187) 100	(3338) 100	(3819) 100
I_2	1	1		(2000) 98	(2372) 99	(2521) 99	(2997) 99
P_1	0	0	2		(528) 87	(600) 95	(1104) 96
C	0	0	1	13		(521) 65	(837) 88
P_2	0	0	1	5	35		(706) 84
M_2	0	0	1	4	13	16	

Females - Maxilla

	M_1	I_1	I_2	P_1	C	P_2	M_2
M_1		(618) 89	(1288) 98	(2987) 100	(3302) 100	(3605) 100	(4089) 100
I_1	11		(766) 99	(2490) 100	(2804) 100	(3111) 100	(3572) 100
I_2	2	1		(1847) 91	(2156) 97	(2444) 98	(2896) 98
P_1	0	0	3		(488) 82	(663) 97	(1151) 97
C	0	0	3	18		(626) 74	(968) 89
P_2	0	0	2	3	26		(743) 81
M_2	0	0	2	3	11	19	

Males – Mandible

	M_1	I_1	I_2	C	P_1	P_2	M_2
M_1		(445) 48	(945) 97	(3239) 100	(3332) 100	(4015) 100	(4077) 100
I_1	52		(924) 99	(3252) 100	(3347) 100	(4033) 100	(4085) 100
I_2	3	1		(2360) 100	(2453) 100	(3137) 100	(3192) 100
C	0	0	0		(354) 63	(838) 97	(927) 95
P_1	0	0	1	37		(721) 98	(858) 93
P_2	0	0	0	3	2		(561) 54
M_2	0	0	0	5	7	46	

Females - Mandible

	M_1	I_1	I_2	C	P_1	P_2	M_2
M_1		(407) 44	(862) 96	(2633) 100	(2959) 100	(3703) 100	(3788) 100
I_1	56		(870) 99	(2782) 100	(3011) 100	(3757) 100	(3833) 100
I_2	4	1		(1844) 99	(2268) 99	(2908) 100	(2888) 100
C	0	0	1		(439) 88	(1112) 98	(1202) 98
P_1	0	0	1	12		(775) 98	(913) 95
P_2	0	0	0	2	2		(578) 56
M_2	0	0	0	2	5	44	

The vertical column indicates the first tooth of a sequence to erupt
The horizontal column indicates the second tooth of a sequence to erupt

Fig 1. Matrices presenting frequencies of tooth-pair emergence sequences in Australian children (rounded to the nearest whole number). Total N for each tooth pair appears only once, in parentheses above the diagonal. For example, of males, 92 per cent displayed M^1I^1 and 8 per cent displayed I^1M^1.

not possible to make comparisons with other studies based on the same population. The most common emergence polymorphism in the maxilla for both sexes involved the canine and second premolar, whereas common polymorphisms in the mandible were noted for the central incisor and first molar, for the canine and first premolar, and for the second premolar and second molar. The frequency of occurrence of the canine-first premolar sequence differed between boys and girls, particularly in the mandible in which the canine preceded the first premolar in 63 per cent of boys compared with 88 per cent of girls.

DISCUSSION

There are some limitations in this type of cross-sectional study of tooth emergence. Firstly, although radiographs are used routinely within SADS to confirm agenesis of teeth, it is possible that some teeth may have been incorrectly recorded as unerupted rather than missing. It is also possible that some teeth recorded as missing may have actually been extracted for orthodontic reasons, or avulsed. However, these sorts of recording errors are unlikely to have biased the summary statistics greatly, given the large size of the sample. Another limitation is that different recorders at SADS clinics around South Australia were involved in filling out the examination sheets, and no replicability study was performed. However, again given that all the recorders were qualified dental therapists and dentists, the number of errors is likely to be small.

In the absence of any other published data for Australians, comparisons of tooth emergence polymorphism frequencies in South Australian children were made with those reported by Holly Smith and Garn[7] for white American children. Similar examples of polymorphic tooth pairs were found to occur in each population, although the frequencies of occurrence differed to varying degrees. For example, the canine-first premolar sequence occurred in 87 per cent of Australian boys and 82 per cent of Australian girls, compared with 81 and 71 per cent of American boys and girls. In the mandible, the central incisor-first molar sequence occurred in 48 per cent of Australian boys and 44 per cent of girls compared with 48 and 59 per cent respectively in Americans. For the mandibular second molar-second premolar sequence, the frequencies were 54 and 56 per cent in Australian boys and girls compared with 76 and 77 per cent in Americans.

Our findings show that the permanent teeth emerged at similar times on right and left sides, that the mandibular teeth tended to emerge earlier than their maxillary counterparts, and that girls tended to be advanced compared with boys, reflecting previous studies in different populations.[8-10] The median ages of emergence of permanent teeth in Australian children

are delayed compared with those reported for Asian children and more recently for Finnish children.[8,11,12] The differences in median ages of emergence of the incisors were notable between the Finnish and Australian samples, being as large as 0.72 years for mandibular incisors in boys and 0.65 years in girls. These findings re-inforce the need to develop and use population-specific standards.

Several factors may have contributed to the differences in timing of permanent tooth emergence of Australian children reported in the early 1960s and the findings of the present study. Clearly, differences could be related to sampling issues and differences in research methodology employed in the three studies. Furthermore, the prevalence of dental caries in Australian children has decreased considerably over the past 40 years, with fewer extractions of deciduous teeth, and this may be associated with an alteration in emergence times of permanent teeth.[13] There is also evidence of secular trends influencing tooth emergence, but this has normally been associated with earlier rather than later emergence.[12,14]

CONCLUSIONS

The data presented in this paper provide new standards for permanent tooth emergence derived from a large sample of Australian children. Generally, median emergence times were delayed compared with those presented in earlier published reports. There are several possible reasons for these differences that may relate to either, or both, methodological and biological issues. Nevertheless, given the size of the sample, it would seem appropriate that dentists and auxiliaries should now refer to these new data as standards when assessing permanent tooth emergence of Australian children.

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