Intra- and Inter-population Variability in Mamelon Expression on Incisor Teeth

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ABSTRACT Although rounded protuberances referred to as mamelons are observed commonly on the crowns of newly-emerged human incisor teeth, there have been very few systematic studies of their expression. The main aims of this study were to describe the nature and extent of variation of mamelon expression on permanent incisors within and between two different human populations, and to quantify the contributions of genetic and environmental influences to observed variability. Mamelon expression was scored according to a 12-grade system described by Fitzgerald *et al.* (1983) using dental models of 104 indigenous Australians, as well as 287 singletons and 175 pairs of twins of European descent. Over 90% of all incisors displayed mamelons, although the pattern of expression differed significantly between maxillary and mandibular arches, tooth types and ethnic groups. There were no significant differences in expression between sexes or antimeric teeth. A three-mamelon form was most common on maxillary and mandibular central incisors in both ethnic groups, but different expressions were observed on lateral incisors. Percentage concordances for monozygotic twin pairs were higher generally than those for dizygotic twin pairs, indicating that genetic factors play a role in determining the variation observed in mamelon expression.

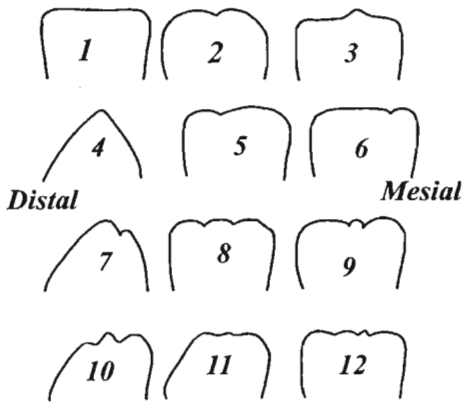

Fig. 1. Fitzgerald 12-grade for scoring mamelons. 1 = straight incisal edge with no evidence of mamelon formation; 2 = median notch; 3 = median dominance; 4 = median prominence with caniniform incisal edge with no lingual or labial grooves; 5 = distal notch; 6 = mesial notch; 7 = median prominence with caniniform incisal edge and mesial or distal notch; 8 = typical three-mamelon configuration with lobes of similar size; 9 = three-mamelon configuration with reduced middle lobe; 10 = three mamelon configuration with prominent middle lobe and tapering distal crown contour; 11. three-mamelon configuration with weak expression and taperong crown distal contour; 12 = four-mamelon configuration with accessory lobe generally between middle and mesial lobes.

INTRODUCTION

Although mamelons were described in early texts of dental anatomy (Black, 1902; Tomes, 1923), these distinct rounded protuberances on the incisal margins of newly erupted incisors have received minimal attention in the anthropological literature, particularly in relation to their frequency of occurrence and variation in expression. The probable reason for this neglect is that mamelons, unlike many other morphological traits on human teeth, are usually worn down quickly and are therefore unobserved. A few researchers have described the normal appearance of the trait (e.g., Kraus et al., 1969; Taylor, 1978), while variations in individuals with cleft lip and/or palate and Down's syndrome have also been reported (e.g., Jordan et al., 1966; Kraus et al., 1968). Mamelons first appear as mesial and distal bulges on either side of a central cusp on the margins of developing incisor crowns, recapitulating the triconodont form of primitive mammalian teeth (Kraus and Jordan, 1965).

Fitzgerald and associates (1983) developed a classification system and carried out a detailed study of normal variation in mamelon morphology in American children. Subsequently, their methods were used by

Fig. 2. Type 3 mamelon expression on mandibular lateral incisors of an indigenous Australian.

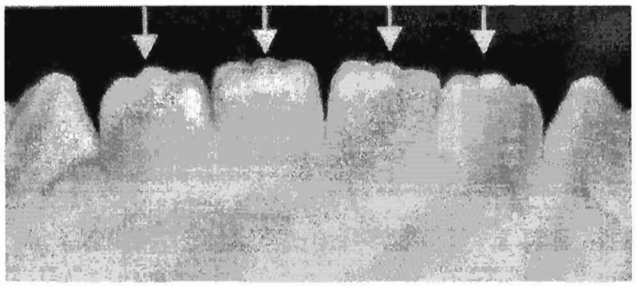

Fig. 3. Mamelon expression in one of a pair of monozygotic twins. Mandibular incisors scored as Type 8 in both twins.

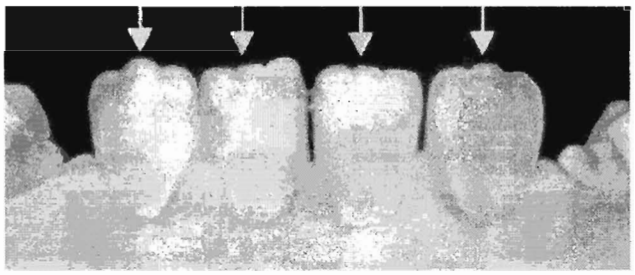

Fig. 4. Mamelon expression in the second of a pair of monozygous twins, Fig. 3 showing the other. Mandibular incisors scored as Type 8 in both twins.

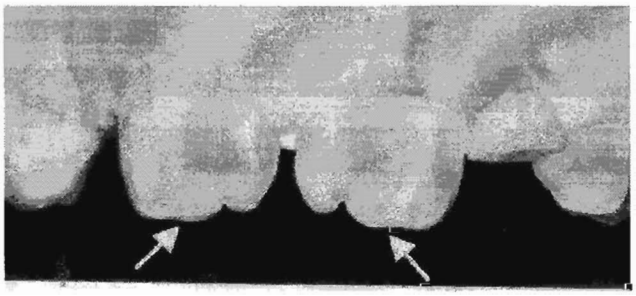

Fig. 5. Mamelon expression in another pair of MZ twins. Maxillary central incisors scored as Type 6 in one twin (Fig. 5).

Schneider et al. (1985) in a study of prehistoric native Americans. Numerous studies, as reviewed by Kieser (1990) and Scott and Turner (1997), have shown that variation in the size and shape of teeth is under relatively strong genetic control, so one would expect a similar influence on mamelon variation. The aims of the present study were; to compare the frequency of occurrence and variation of mamelon expression within and between large samples of Australians of European descent and indigenous Australians; and to examine a sample of twins in order to determine the relative contributions of genetic and environmental influences to mamelon variation.

MATERIALS AND METHODS

Observations were made on dental models of 104 indigenous Australians, 175 pairs of twins of European descent and 287 singletons of European descent. The indigenous Australian sample included 57 males and 47 females, aged from five to 12 years. The sample of twins included 72 monozygotic (MZ) pairs and 103 dizygotic (DZ) pairs, aged from 6 to 12 years. Of the MZ pairs, 47 were female and 25 male, whereas in the DZ samples there were 44 female-female, 36 male-male and 23 female-male pairs. The sample of singletons included 172 females and 115 males. Mamelon patterns on the eight permanent incisors were recorded, and teeth with any sign of wear were excluded.

Different mamelon configurations were classified and described on the basis of the 12-category scheme described by Fitzgerald and colleagues (Fig. 1). Mamelons were scored according to the closest category, but two new categories were formed for teeth displaying either five or six mamelons.

The dental models of indigenous Australians and twins were scored twice and percentage concordances calculated to determine the reliability of the scoring procedure. Concordances between repeated observations were high (over 90% for indigenous Australians and 95% for twins) for all mamelon configurations. The frequency of occurrence and degree of expression of mamelons were determined and compared by means of chi-square analysis for each incisor type, antimeric teeth,

and maxillary and mandibular arches, as well as for sex and ethnic group. Concordances for all mamelon patterns were also compared between monozygotic (MZ) and dizygotic (DZ) pairs. The total samples included 486 permanent incisors of indigenous Australians, 792 permanent incisors of twins of European descent and 967 permanent incisors of singletons of European descent.

RESULTS

Chi-square analyses comparing mamelon expression between males and females, and between right and left incisors in each of the study samples failed to disclose any significant differences, so data for sexes were pooled and those for right side only reported. Significant differences were noted between incisor types and between maxillary and mandibular arches, so frequency data for each of the four tooth types are presented separately (Tables 1 to 4).

In the maxilla the configuration of three lobes (Type 8) was most common on central incisors in both populations (over 60% in those of European descent and 32.7% in indigenous Australians), followed by Type 12, a category with an accessory fourth lobe (around 27% in those of European descent and 20.4% in indigenous Australians). For maxillary lateral incisors Type 3 was the most common configuration in indigenous Australians (over 53.7%) followed by Type 12 (12.2%). In contrast, the most common categories in maxillary laterals in singletons of European descent were Type 2, Type 6 and Type 8 (33.3%, 15.4% and 15.4% respectively). In twins the most common patterns for the lateral incisor were Types 2 and 6 (both 21.8%), followed by Type 3 (17.9%).

Mandibular incisors, particularly centrals, were essentially invariant in mamelon pattern. Over 90% of mandibular central incisors, regardless of ethnic group, expressed a typical form of three equal-sized mamelons (Type 8), as described in most dental textbooks. On mandibular lateral incisors of twins and singletons Type 8 was also the most common configuration (over 68.9% in singletons and 57% in twins) with Type 3, a configuration with a median prominence, next (18.9% in singletons, 39.8% in twins). Only 11.3%

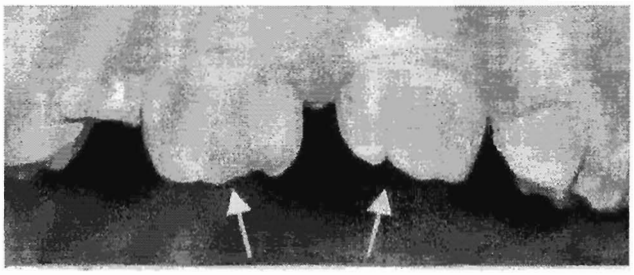

FIG. 6. Mamelon expresssion in the other pair of MZ twins. Maxillary central incosors scored as Type 12 (right central incisor) and Type 8 (left central incisor) in the other twin (Fig. 6).

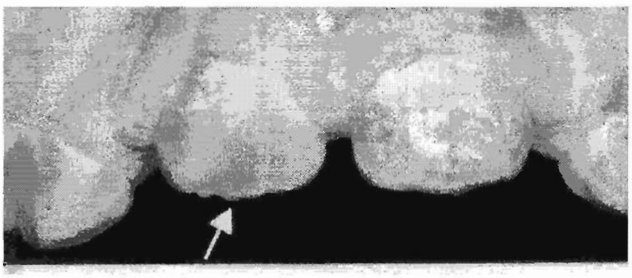

Fig. 7. Type 13 five-mamelon expression on a maxillary right central incisor of an indigenous Australian.

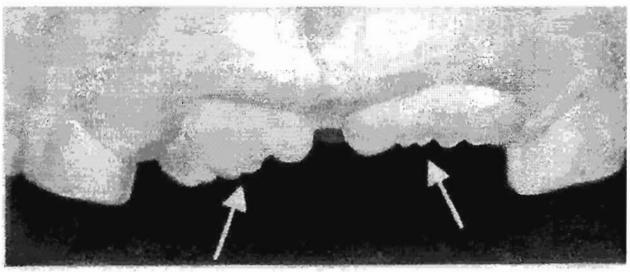

Fig. 8. Type 14 six-mamelon expression on both maxillary central incisors of a subject of European descent.

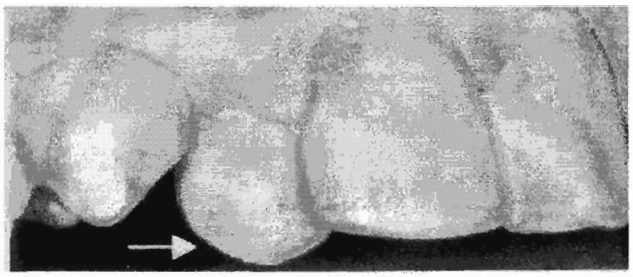

Fig. 9. Type 4 mamelon expression on the maxillary right lateral incisor of an indigenous Australian.

of mandibular lateral incisors of indigenous Australians exhibited Type 8 while most (over 77.5%) presented Type 3 (Fig. 2).

Genetic analysis was conducted on the twin samples by comparing the percentage concordances between MZ and DZ twin pairs. For all four incisor types, MZ twins demonstrated higher concordances between the pairs than DZ twins (Table 5). Figures 3 to 6 show mamelon expression in two pairs of MZ twins. In one pair, the lower incisors showed the same pattern of mamelons, whereas in the other pair the patterns differed slightly.

DISCUSSION and CONCLUSION

Our results showed no significant differences in the frequency of various mamelon patterns between sexes or antimeric teeth. However, there was a significant difference in the distribution of mamelon patterns between maxillary and mandibular dental arches. The present study also demonstrated a significant difference in the frequency of mamelon patterns between ethnic groups, with Type 3 being the most prevalent configuration on lateral incisors in indigenous Australians, both in the maxilla and mandible. In contrast, Type 8 was the most common category in the lower lateral incisors and Type 2 was the most common in the maxillary lateral incisors of subjects of European descent. Mandibular incisors, particularly central incisors, were essentially invariant in mamelon expression in both ethnic groups, whereas maxillary laterals demonstrated the highest range of variation.

Fitzgerald et al. (1983) referred to some variations as being outside the normal range, e.g., five mamelons. In our study five mamelons were observed on the incisors of some individuals and were considered to fall within the normal range of variation (classified as Type 13). An example is provided in Figure 7. Furthermore, we observed six mamelons in two cases (classified as Type 14) and an example is illustrated in Figure 8. In addition, Fitzgerald et al. (1983) did not observe Type 4 in permanent incisors and stated that it occurred only in primary incisors. However, in one indigenous Australian subject, the overall shape of the maxillary lateral incisor conformed with Type 4 configuration, similar to the labial profile of a canine (Fig. 9). Apart from these differences, the 12-grade system developed by Fitzgerald and colleagues appears to be a reliable method that captures most of the observed variation in mamelon morphology.

Comparisons of the percentage concordances for mamelon expression between monozygotic (MZ) and dizygotic (DZ) twin pairs revealed that MZ twins had the higher concordances for all four incisor types. This result provides some indication of a genetic basis to mamelon variation, but more sophisticated genetic modelling approaches applied to larger samples of twins are needed to confirm these preliminary findings.

SUMMARY

Our study of mamelons has shown that there are differences in trait expression between indigenous Australians and Australians of European descent, and that there is an underlying genetic basis to observed variation. Further studies are required to better understand the extent and causes of variation in mamelon expression in different human populations.

TABLE 1. Frequency of mamelon patterns in maxillary right central Incisors.

Category	Indigenous Australians n	%	Singletons n	%	Twins n	%
1	9	18.4	3	2.3	2	2.7
2	2	4.1	-	-	1	1.4
3	2	4.1	1	0.8	-	-
4	-	-	-	-	-	-
5	4	8.2	-	-	2	2.7
6	3	6.1	1	0.8	3	4.1
7	-	-	-	-	-	-
8	16	32.7	85	64.9	44	60.3
9	1	2.0	4	3.1	1	1.4
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	10	20.4	35	26.7	20	27.4
13	2	4.1	1	0.8	-	-
14	-	-	1	0.8	-	-

Significant difference in distribution of major mamelon types (1, 8, 12) between the three study samples X^2 = 27.5, d.o.f.= 4, p<0.01. Two additional categories are added to th0se in Fig. 1: Type 13 for five mamelon, Type 14 for six mamelon configurations.

TABLE 2. Frequency of mamelon patterns in maxillary right lateral incisors.

Category	Indigenous Australians n	%	Singletons n	%	Twins n	%
1	2	4.9	9	7.3	8	10.3
2	3	7.3	41	33.3	17	21.8
3	22	53.7	18	14.6	14	17.9
4	2	4.9	1	0.8	-	-
5	1	2.4	-	-	-	-
6	2	4.9	19	15.4	17	21.8
7	-	-	-	-	-	-
8	1	2.4	19	15.4	13	16.7
9	1	2.4	6	4.9	4	6.4
10	1	2.4	-	-	-	-
11	-	-	1	0.8	-	-
12	5	12.2	9	7.3	4	5.1
13	1	2.4	-	-	-	-

Significant difference in distribution of major mamelon types (1,2, 3, 6, 8, 9, and 12) between the three study samples X^2 = 46.8, d.o.f.= 12, p<0.01. One additional category is added to those in Fig. 1: Type 13 for five mamelon, Type 13 for five mamelon configuration.

TABLE 3. Frequency of mamelon patterns in mandibular right central Incisors.

Category	Indigenous Australians n	%	Singletons n	%	Twins n	%
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	5	6.9	2	1.7	3	2.0
4	-	-	-	-	-	-
5	1	1.4	1	0.9	-	-
6	-	-	5	4.3	-	-
7	-	-	-	-	-	-
8	66	91.7	106	90.6	145	96.0
9	-	-	1	0.9	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	2	1.7	3	2.0

Significant difference in distribution of mamelon type 8 between the three study samples
X^2 = 29.5, d.o.f.=2,p<0.01.

TABLE 4. Frequency of mamelon patterns in mandibular right lateral incisors.

Category	Indigenous Australians n	%	Singletons n	%	Twins n	%
1	-	-	1	0.9	-	-
2	1	1.3	-	-	1	1.1
3	62	77.5	20	18.9	37	39.8
4	-	-	-	-	-	-
5	3	3.8	1	0.9	-	-
6	2	2.5	5	4.7	2	2.2
7	-	-	-	-	-	-
8	9	11.3	73	68.9	53	57.0
9	3	3.8	3	2.8	-	-
10	-	-	01	0.9	-	-
11	-	-	-	-	-	-
12	-	-	2	1.9	-	-

Significant difference in distribution of major mamelon types (3 and 8) between the three study samples
X^2 = 88.2, d.o.f. = 3,p<0.01

Table 5. Twin concordances (%) for mamelon pattern (right incisors only)

	MZ		DZ	
Incisor types	n	%	n	%
Maxillary central incisors	25	66.7	16	62.5
Maxillary lateral incisors	28	72.2	17	47.1
Mandibular central incisors	32	100.0	33	97.0
Mandibular lateral incisors	25	96.0	18	77.8

n = number of twin pairs

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