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Comparative evaluation of posterior tooth dimensions among twin pairs from a unique village of twins: an ex-vivo study

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Abstract
Comparisons within monozygotic and dizygotic twin pairs can provide valuable insights into the relative contributions of genetic and environmental influences on the variation in tooth size. Twenty-two twin pairs (12 dizygotic twins, 10 monozygotic twins) aged 13 – 25 years who met the inclusion and exclusion criteria were considered. Mesio-distal measurements of maxillary and mandibular permanent posterior teeth to their maximum width were measured from the dental casts obtained from the twin pairs. Intra-pair differences showed statistically significant differences (p<0.05) of tooth dimensions among dizygotic (DZ) twins were found in 4 of the 16 posterior teeth studied. No statistically significant differences (p>0.05) were found in all 16 posterior teeth studied among monozygotic (MZ) twins. Mean differences were greater between members of the dizygotic twin pairs compared to monozygotic twin pairs. This study substantiates the evidence of genetic control in tooth size.

Keywords: Dizygotic twins, genetics, monozygotic twins, tooth size, twin study

Introduction
Tooth breadth is a characteristic controlled by hereditary forces. The cause of irregularities of teeth is due to the inheritance of large teeth in proportion to the size of the inherited jaw. The harmonious relationship between arch length and teeth dimension results in the development of a satisfactory alignment and optimum occlusion of teeth [1, 2]

The normal variation in tooth size is the result of multi-factorial inheritance with both genetic and environmental factors being important. Dizygotic (DZ) twins are expected to show about the same intra-pair variability as siblings, whereas the differences between monozygotic (MZ) twins are usually of similar magnitude to the minor left–right differences often noted in singletons. More specifically, monozygotic (MZ), or 'identical', twins share nearly 100% of their genetic polymorphisms whereas Dizygotic (DZ), or 'fraternal', twins share only about 50%. Studies with DZ twins are helpful because they tend to share many aspects of their environment by virtue of being born at the same time and place [3, 4]. Genetic basis of variation is best explained by the polygenic model of inheritance [5]. Without information about the size of individual teeth and groups of teeth, it is difficult for a clinician to carry out the therapy which is based upon prompt diagnosis and treatment plan [6, 7].

Determination of the actual level of genetic determinacy of occlusal variation could have a significant effect on the prognosis and treatment planning. This study was carried out to analyse the hereditary variation which occurs in mesio-distal dimension of maxillary and mandibular posterior teeth (excluding the third molars) among members of the twin pairs. The objectives of this study were to assess the presence of a measurable component of morphological variability by comparing the average of the differences between the teeth of identical and non-identical twins and assess the quantitative variation that occurs in the widest mesio-distal tooth dimension of the maxillary teeth (excluding the third molars) and the mandibular teeth (excluding the third molars).

2. Materials and Methods
An Ex-Vivo study was conducted among 22 twins aged 13 – 25 years born in Kodinhi Village, Kerala, India. Protocol for the study was presented to the Ethical Committee of Yenepoya

University, Mangalore, Karnataka, India following which the approval was obtained (YUEC 97/23/9/2013). Informed Consent and Assent were obtained. Twins with a full complement of completely erupted permanent teeth and born in Kodinhi village were included in the study. Subjects with ongoing orthodontic treatment, subjects who do not consent to the examination and subjects with posterior permanent dentition restored with porcelain or acrylic jackets and those which had either carious lesion or restoration which affected a contact point were excluded from the study.

Sterilization of the instruments was done by autoclave and chemical sterilization on the spot whenever required. Dental impressions were registered using irreversible hydrocolloid (alginate) impression material for both maxillary and mandibular arches and were poured immediately with dental stone to obtain the dental casts. Mesio-distal crown dimensions were measured from dental casts of the permanent teeth. Casts with an intact mesio-distal diameter of the crown of permanent teeth, not affected by any caries, restorations, attrition and with no history of previous orthodontic treatment were considered for the analysis.

Mesio-distal widest diameter measurements of the following teeth (Maxillary and Mandibular posterior permanent dentition) were taken using the Digital Vernier calliper on the study models. The legs of the calliper were placed at the widest mesio-distal points and the instrument was held parallel to the occlusal surfaces of the teeth as the individual teeth were measured. Federation Dentaire Internationale (FDI) tooth numbering system was used in the current study.

The descriptive statistics were used to obtain frequency, mean and standard deviation. The differences of the widest mesio-distal widths with respect to each of the posterior permanent dentition were calculated. The data obtained in the current study were tabulated by measuring the widest mesio-distal width of each posterior permanent tooth for each of the twin members within the twin pair. Shapiro-Wilk's test and a visual inspection of histograms showed that the measured values were approximately normally distributed thus the level of significance was tested using Paired-*t*-test. Statistical tests were done using SPSS 21.0 (Statistical Package for Social Sciences; IBM Statistics, 2012). The level of significance was set at 0.05 and *p*-value < 0.05 was considered significant.

3. Results

Of the 22 pairs of twins (25 males and 19 females), 12 pairs were Dizygotic (DZ) and 10 pairs were Monozygotic (MZ). Statistically significant differences ($p<0.05$) among dizygotic twins were seen in relation to right and left maxillary second molar (Table 1) and mandibular first premolar (Table 2). Among monozygotic twins statistically insignificant differences ($p>0.05$) were seen in relation to all posterior teeth studied (Table 3 and 4). The mean differences were much greater between members of the dizygotic twin pairs compared to the monozygotic twin pairs.

Table 1: Mesio-distal dimensions of maxillary posterior permanent teeth among Dizygotic (DZ) twins

Tooth Number	Pair	Mean	Standard Deviation	Mean Difference	t-value	p-value
14	A	7.60	0.74	0.02	0.09	0.93
	B	7.58	0.47			
15	A	7.38	0.43	0.17	1.17	0.27
	B	7.21	0.40			
16	A	10.59	0.40	0.11	2.60	0.09
	B	10.70	0.54			
17	A	9.38	0.38	0.38	2.28	0.04*
	B	9.76	0.40			
24	A	7.50	0.64	0.08	0.56	0.59
	B	7.42	0.42			
25	A	7.38	0.43	0.17	1.17	0.27
	B	7.21	0.40			
26	A	10.49	0.40	0.21	2.60	0.25
	B	10.70	0.54			
27	A	9.38	0.38	0.37	2.28	0.04*
	B	9.75	0.40			

Number of subjects = 12

* = mean difference statistically significant ($p<0.05$)

Table 2: Mesio-distal dimensions of mandibular posterior permanent teeth among Dizygotic (DZ) twins

Tooth Number	Pair	Mean	Standard Deviation	Mean Difference	t-value	p-value
44	A	7.50	0.56	0.29	3.92	0.002*
	B	7.21	0.50			
45	A	7.46	0.33	0.04	0.36	0.72
	B	7.42	0.51			
46	A	10.91	0.63	0.16	1.17	0.27
	B	11.08	0.51			
47	A	10.08	0.70	0.17	0.77	0.46
	B	9.92	0.76			
34	A	7.50	0.56	0.29	3.92	0.002*
	B	7.21	0.50			
35	A	7.46	0.33	0.04	0.36	0.72
	B	7.42	0.51			
36	A	10.92	0.63	0.25	1.91	0.08
	B	11.17	0.58			
37	A	10.08	0.70	0.17	0.78	0.46
	B	9.91	0.76			

Number of subjects = 12

* = mean difference statistically significant ($p<0.05$)

Table 3: Mesio-distal dimensions of maxillary posterior permanent teeth among Monozygotic (MZ) twins

Tooth Number	Pair	Mean	Standard Deviation	Mean Difference	t-value	p-value
14	A	7.20	0.85	0.10	0.45	0.66
	B	7.10	0.46			
15	A	6.90	0.74	0.00	0.00	1.00
	B	6.90	0.21			
16	A	10.30	0.48	0.15	1.00	0.34
	B	10.15	0.34			
17	A	9.45	0.60	0.10	0.69	0.51
	B	9.35	0.47			
24	A	7.20	0.85	0.10	0.45	0.66
	B	7.10	0.46			
25	A	6.90	0.74	0.20	1.81	0.10
	B	6.70	0.63			
26	A	10.30	0.48	0.05	1.00	0.34
	B	10.35	0.47			
27	A	9.45	0.59	0.10	0.68	0.51
	B	9.35	0.47			

Number of subjects = 10

* = mean difference statistically significant ($p<0.05$)

Table 4: Mesio-distal dimensions of mandibular posterior permanent teeth among Monozygotic (MZ) twins

Tooth Number	Pair	Mean	Standard Deviation	Mean Difference	t-value	p-value
44	A	7.30	0.35	0.25	3.00	0.08
	B	7.05	0.16			
45	A	7.25	0.35	0.05	0.43	0.68
	B	7.20	0.35			
46	A	10.75	0.82	0.10	1.00	0.34
	B	10.85	0.63			
47	A	9.80	0.71	0.05	0.36	0.73
	B	9.85	0.97			
34	A	7.30	0.35	0.25	3.00	0.08
	B	7.05	0.16			
35	A	7.25	0.35	0.05	0.43	0.68
	B	7.20	0.35			
36	A	10.75	0.82	0.10	1.00	0.34
	B	10.85	0.63			
37	A	9.80	0.71	0.05	0.36	0.73
	B	9.85	0.97			

Number of subjects = 10

* = mean difference statistically significant ($p<0.05$)

4. Discussion

Twins give the information about the genetic basis of complex traits and for examining genetic and environmental influences on behavioural and medical characteristics. Twin studies are a fascinating method of research because of their ability to correctly isolate a characteristic and determine its impact. Although it is difficult to predict the exact influence of heredity due to various genetic patterns, twin studies are instrumental in offering evidence against the purely environmental model [8-10].

Kodinhi (*11.0410°N, 76.0830°E*) a village in Malappuram District, Kerala, India a hometown to 2,500 families took the scientific world by surprise as a survey done by the locals found an unusual number of twin births. It is estimated that there are nearly 250 twin pairs of which 79 twin pairs are with the age of 0 – 10 years and the oldest being born on 1949. The mystery behind the unusual rate of twin birth is a puzzling phenomenon as the average rate of twinning (42 of 1,000 live births) in this village is much higher than the global average of twinning (6 of every 1,000 live births). Another interesting fact is that the women married off from this village and also married to the men in Kodinhi also give birth to twins [11]. A similar kind of twin birth has been reported only in two other villages – Igbo-Ora (Nigeria) and Cândido Godói (Brazil).

The complex morphological characteristics, such as the mesio-distal tooth dimension is influenced by both hereditary and environmental factors. The effect of non-genetic factors on the size of molar teeth has been demonstrated by Paynter KJ and Grainger RM (1956) [12] and it has been mentioned that this is one aspect of tooth development which requires further investigation.

The presently conducted study compared between the two members among a monozygotic twin pair whose genetic inheritance coefficient is 1.0 which means that any observed variation would be due to factors other than heredity. In case of dizygotic twins (genetic inheritance coefficient is 0.5) any observed differences between the two members result from the same influences which affect monozygotic twins plus a one-half of their total heredity [2].

The present investigation is concerned with the analysis of the quantitative hereditary variation in 22 twin pairs by means of assessment of the mesio-distal dimension of maxillary and mandibular posterior permanent dentition. The results show that teeth measured showed mean differences which were much greater between the members of the dizygotic twin pairs compared to the monozygotic pairs. The intra-pair difference between members of monozygotic pairs was not statistically significant with respects all posterior teeth. Intra-pair statistically significant differences were found with respect to maxillary left and right second molar and right and left

mandibular first premolar among dizygotic twins.

The presently conducted study contrasts with results obtained by Sharma K *et al* (1985) [13] on the genetic analysis variation of 56 tooth size traits based on a sample of 58 pairs of twins from Chandigarh, India which showed that higher variance was seen among Indian monozygotic twins than dizygotic twins. The study reported a complex environmental determination for some dental dimensions, especially among incisors and second molars.

Statistically insignificant results for intra-pair comparison between the members of monozygotic pairs with respect to all posterior teeth studied in the present study substantiates the evidence that size of teeth is under genetic control. This is in concordance with the studies by conducted Horowitz *et al* (1958) [2] and Di Salvo *et al* (1972) [14] on the effect of hereditary factors on tooth dimensions where they concluded that genetically conditioned variations of a highly significant nature occurred in the majority of the teeth studied. A study by Kabban M *et al* (2001) [3] also showed monozygotic twins showed greater concordance than dizygotic twins for all permanent teeth with statistically significant variance for the mesio-distal variation. A study on dentition and dental arch using three sets of same-sex triplets, two sets being monozygotic and one set dizygotic carried by Menezes *et al* (1974) [15] also concluded that size and form of the dentition is more under genetic control than the size and the form of the arch.

In this context, Horowitz *et al* (1958) [2] study on permanent anterior teeth showed that the canine tooth however, showed a low heritability component of variation. The limited genetic variability canine observed their study is compatible with Dahlberg's hypothesis (1945) [16] as is the observation in relation to the second molar in the current study. The key to the determination of malocclusion and its treatment lie in the ability to differentiate the effect of genes and environment on the craniofacial skeleton in a particular individual. Meticulous calculation and analysis of mesio-distal widths teeth in posterior permanent dentition excluding the third molar in this study has shown that hereditary factors play a significant role in the determination of tooth ratios.

Considering the cross-sectional nature of the present study, there is scope for future research involving the measurement of the entire dentition, using additional diagnostic aids (X-rays – Not employed in the present study due to ethical reasons and social constraints) to find the genetic variability among monozygotic and dizygotic twins.

5. Conclusion

The conclusion drawn on completion of the study from the findings based on 22 pairs of twins studied gives evidence that size of teeth is under genetic control. It is possible for these teeth, that there is an association of time, size and genetic control.

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