Frequency and Variability of Five Non-Metric Dental Crown Traits in the Primary and Permanent Dentitions of a Racially Mixed Population from Cali, Colombia

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ABSTRACT: The purpose of this study was to determine the prevalence and variability of five non-metric dental crown traits (Carabelli cusp, protostylid, groove pattern, and cusps 6 and 7) in the deciduous (Um2 and Lm2) and permanent (UM1 and LM1) teeth in children in the mixed-dentition, and to compare these frequencies with the literature. A descriptive study was conducted to characterize the dental morphology of young subjects in mixed dentition stages. The Arizona State University Dental Anthropology System (ASUDAS) and Grine, Sciulli, and Hanihara methods were used as reference to compare the prevalence of dental traits in dental casts from 100 subjects from a Colombian racially mixed population. The high prevalence of furrows and pits of the Carabelli cusp, minor expressions of the protostylid (foramen cecum), and the low frequencies of cusps 5 and 6, plus the behavior of the expression of groove pattern collectively suggest that this group reflects influences by both the Mongoloid and Caucasoid dental complexes. Correspondence of trait expression in both the primary and permanent dentition was also demonstrated ($P < 0.05$). Some of the non-metric trait frequencies also exhibited sexual dimorphism. *Dental Anthropology* 2006;19(2):39-47.

Dental anthropology is the area of study that integrates anthropology, dentistry, biology, paleontology and paleopathology in order to holistically investigate the human dentition, such as the anatomical, evolutionary, pathological, and cultural variations with regard to life conditions, culture, feeding patterns and past adaptation processes in human populations. The scope of study includes metric and non-metric dental traits, dental pathology and intentional plus occupational modifications of the teeth (Scott and Turner, 1997, 1998; Alt *et al*., 1998; Rodríguez, 1999; Rodríguez and Delgado, 2000; Mayhall, 2000; Rodríguez, 2004). One facet of dental anthropology is dental morphology. Dental morphology is the discipline used to register, analyze, interpret and understand all aspects of dental crown and root morphology that can inform us about human groups, such as their cultural activities, biological conditions, and quality of life (Rodríguez, 2004).

From this perspective, teeth are informative indicators for the study of human populations, serving as markers and the bases for comparisons of genetic origin, allowing for the classification of human groups in taxonomic, phylogenetic and evolutionarily categories by means of their frequency, sexual dimorphism, bilateral symmetry and morphological characteristics (Rodríguez, 1999; Rodríguez, 2003a). This is possible because teeth commonly are preserved even in the extreme conditions in which skeletal remains are found. Teeth are the organs that are best preserved because enamel is the hardest tissue of the human body, having the capacity to resist high temperatures and taphonomic processes (*e.g*., time, environment, pH, salinity, humidity, attack by trace elements) (Rodríguez, 2004; Moreno and Moreno, 2005). Consequently, teeth constitute a means of personal identification where other information may be unavailable, thus contributing to an unknown individual's osteobiographical reconstruction through forensic means (Krogman, 1986). Also, in archeological and anthropological contexts, dental anthropology can help estimate a populations' temporal position to clarify its history, origin, formation, contacts and displacements of current and past human groups (Moreno and Moreno, 2005; Rodríguez, 2003a; Turner *et al*., 1991).

Non-metric dental crown traits (NDCT) are phenotypic forms of the enamel that are inherited and controlled in their location, growth and orientation; they result from indirect processes of mineral secretion mediated by proteins the dental morphogenesis, and they are expressed and regulated by the human genome of each individual. These traits can be described as positive (cusps) or negative structures (pits, furrows

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and grooves) that have the potential to be present or absent in a specific place (frequency), in a different form or grade (variability), and in one or more members of a populational group. To date, there are more than 100 non-metric dental crown and root traits described in the human dentition (Rodríguez, 2003a); in the present investigation, three traits were used that occur on the crown complex of primary second molars and permanent first molars.

In the dental literature, NDCT are described using a broad host of names, such as characters, variants, aspects, attributes, polymorphisms, anomalies, discrete traits, and epigenetic or phenotype expressions (Rodríguez, 2003a,b; Rodríguez, 2003). The study of NDCT has demonstrated that the traits are of high taxonomic value; they can be used to estimate biological relationships among groups, allowing researchers to reconstruct and establish intergroup relationships for the comparative analysis of historical, cultural and biological development of primitive and modern human groups. NDCT seem to seldom exhibit sexual dimorphism; statistical associations among traits seem to be low; and there is considerable geographic variation in trait frequencies. NDCT are easily observed and recorded; they thus are useful for establishing population differences according to a group's specific microevolutionary processes, which furnishes information about the displacements and contacts that have taken place (Rodríguez, 2003a,b; Rodríguez, 2003; Tocheri, 2002).

In Colombia, dental anthropology research is primarily concerned with forensic applications and the dental pathological study of pre-Hispanic populations. These interests are carried out by the Physical Anthropology Laboratory of the National University of Colombia, the Biological Anthropology Research Group GIAB, and the Anthropology Departament of Cauca University.

It is necessary to note that the few investigations in this part of the world that have characterized dental morphology have focused on pre-Hispanic populations, plus a few current and modern populations. These latter studies have been limited to the permanent dentition. It is important to keep in mind that the complete primary dentition persists for only a short time; it begins at six months and finishes at two a half years, then it stays intact until about six years, and finally disappears about 12 years of age (Clarke, 1998). In spite of this transience, research on the deciduous dentition provides an excellent model for studying variation of growth within an individual since, in both dental and anthropological contexts, the dentition constitutes a unique source of information about development (Smith *et al*., 1997).

In addition, investigators have studied the primary dentition in various human groups, finding interesting data on the intergroup variations of NDCT. A pioneer in this field was K. Hanihara (*e.g*., 1966, 1968), who established the Mongoloid dental complex as it relates to the permanent and primary dentitions. Other researchers, such as Kitagawa *et al*. (1995) and Kitagawa (2000), have shown that the morphology of primary teeth is efficient for the study of biological affinities among human populations, contributing to the understanding of human dental evolution. Lease and Sciulli (2005) concluded that the morphology of the primary dentition is useful for establishing the identity of children, for the biological discrimination of two or more human groups, and for establishing differences in development between the deciduous to the permanent dentition.

The objective of the present study was to determine the frequency and variability, sexual dimorphism, and bilateral symmetry of five NDCT, namely Carabelli's trait, the protostylid, molar groove pattern, and cusps 6 and 7, of the primary second molars (Um2 and Lm2) and the permanent first molars (UM1 and LM1), which coexist in the mouth between about six years (± 24 months) and ten years of age (± 30 months) (Schour, 1941; Rodríguez, 2004). The goal, then, was to compare these frequencies in both dentitions, with the purpose of understanding the developmental behavior of these three features, the dominant ethnic influence, and the dental morphological characters of the sample. We hope that these findings will contribute to discussions of the usefulness of dental morphology as an anthropological tool, not only in the context of dentistry, but also that of forensic studies (Edgar, 2005; Moreno and Moreno, 2005; Moreno *et al*., 2004).

MATERIALS AND METHODS

Samples

This is a descriptive cross-sectional study concerning the frequency and variability of five NDCT in 100 children (50 male and 50 female) selected randomly from a single living population of a racially mixed group from Cali, Colombia (Fig. 1). The children studied here were 6 to 12 years of age. In order to be included, the subjects had to met four criteria, namely (1) they had to have Colombian parents and grandparents, (2) they had to be healthy dentally without any congenital anomaly, (3) they had to exhibit no severe attrition or abrasion, and (4) they had to possess upper and lower first permanent molars and primary second molars.

Morphological analysis standardization

For the observation of the five NDCT in the permanent dentition this study used the Arizona State University Dental Anthropology System (ASUDAS) (Turner *et al*., 1991; Turner *et al*., 1994). This system allows for finer discrimination than just the dichotomy of presence-absence of traits, it promotes reproducibility among observers, and it generates data that express the variability of expression of each NDCT along with the potential extremes. For analysis of the deciduous dentition, this study used the ASUDAS method for cusp

Fig. 1. Cali, Colombia geographic localization

7, the Hanihara method (1966) for the cusp 6, the Grine method (1986) for the Carabelli trait, and the Sciulli method (1998) for the protostylid and molar groove pattern. These complementary methods, along with the grading systems, are described in the Appendix.

Turner *et al*. (1991) described 29 NDCT that can be applied in populational investigations based on their prevalence and variability. These authors suggest that this suite of NDCT involves clear expressions of the genotype and that they are little-influenced by environmental factors when scored on key teeth as defined by the morphogenetic field concept (Dahlberg, 1945). For the present study, Carabelli trait, protostylid, molar groove pattern, and cusps 6 and 7 cusps are used.

Calibration

The authors practiced the handling of Arizona State University Dental Anthropology System (ASUDAS) and the Hanihara, Grine and Sciulli methods by making repeated series of observations and then comparing among observers to achieve consistency. Repeated comparisons led to standardization of concepts among observers. We applied the kappa statistic (Stata 6.0) to assess repeatability; analysis disclosed inter-observer agreement values of 82.3% and intra-observer 81.2%, following the method suggested by Nichol and Turner (1986).

Tooth Impressions and study casts

This investigation was endorsed by the Human Ethics Committee of the University of the Valley according to the Ministry of Health of the Republic of Colombia (1993) and the Ethical Principles for Medical Research Involving Human Subjects indicated for the World Medical Association in the Helsinki Declaration (1964). After obtaining the signed written consent and the intraoral examination, dental impressions were taken from the subjects using sterile plastic small buckets (Coe for ID®) and alginate (Hydrogum®). Casts were immediately processed in dental stone (WhipMix®) to prevent distortion.

Observation and Statistical analysis

With the obtained study casts, the best calibrated observer performed the analysis using a stereomicroscope (Carl-Zeiss®) at 10-power, evaluating three NDCT: Carabelli trait, protostylid and molar groove pattern in the primary and permanent dentitions. The resulting data were processed using the SPSS® software version 10. Several statistical tests were applied (chi-square tests, univariate and bivariate comparisons, Mann-Whitney U) for each of the NDCT. The conventional level of alpha = 0.05 was considered to be statistically significant.

RESULTS

The principal objective of this research was to observe the existing relationship of the NDCT studied between primary and permanent dentitions. Results were determined to be positive with regard to the Carabelli trait and protostylid frequencies. The groove pattern did not exhibit a significant association between molars in the two dentitions.

Analysis of the expression of the NDCT between girls and boys showed that there was no detectable sexual dimorphism in the primary or the permanent teeth for these three traits, but there was considerable bilateral symmetry of all three features in the primary and permanent dentitions (Tables 2 and 3).

In deciduous and permanent teeth, Carabelli trait most commonly exhibited the fossa form on the cusp. Viewed as a dichotomous trait, it is absent in this sample (Figs. 2 and 3).

The protostylid occurred as grade 1 (foramen cecum) in the majority of cases in both the primary and permanent teeth (Fig. 4). Expressions of the protostylid pit were far more common than the cusp form (Tables 2 and 3).

Inspection of the molar groove patterns showed that the Y and + pattern were common in both dentitions, although in primary teeth there was a higher frequency of the Y configuration and a higher frequency of the + form in the permanent teeth (Table 2; Fig. 5).

The frequency of cusp 6 and 7 was low in both

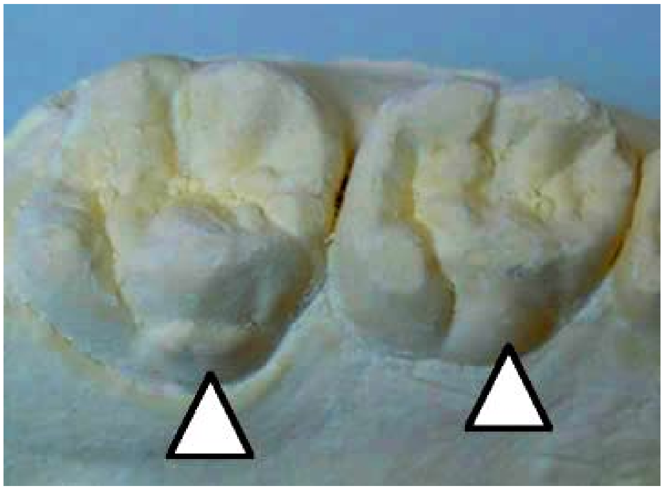

Fig. 2. Carabelli trait: cusp expression in primary second molar (Um2) and permanent first molar (UM1).

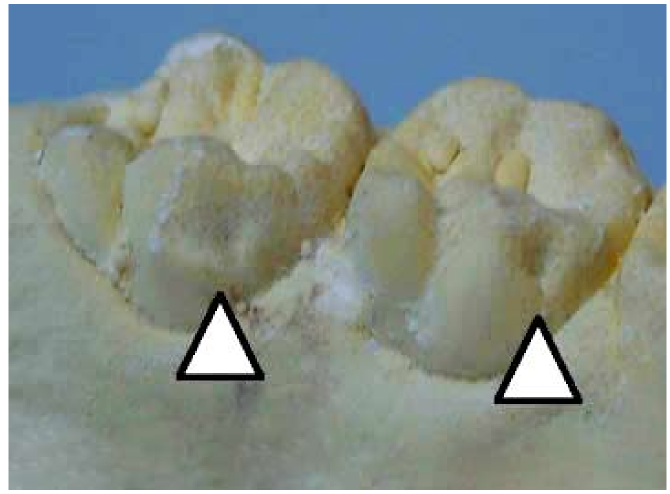

Fig. 3. Carabelli trait: fossa expression in primary second molar (Um2) and permanent first molar (UM1).

dentitions, although cusp 7 is more common than cusp 6 (Table 2; Figs. 6 and 7).

DISCUSSION

Carabelli trait

Kieser (1984) observed a high frequency of this trait in both the deciduous and permanent teeth. Joshi (1975) studied a Hindu population and found that there is a relationship between the prevalence of the feature, bilateral symmetry expression and high prevalence in the groove and fossa forms on the tubercle and cusp forms. Saunders and Mayhall (1982) studied five NDCT on the primary and permanent teeth of a sample of American whites, finding strong positive associations between traits in the two dentitions.

K. Hanihara (1954) carried out several of studies on the trait frequencies of NDCT in primary and permanent dentitions of Asian, Polynesian and Australians, contemporary and prehistoric. Hanihara focused on the NDCT that characterize the Mongoloid complex (shovel-shape, protostylid, deflecting wrinkle, cusps 6 and 7) and the Carabelli trait. As for this last trait, Hanihara (1976) determined that Caucasoid populations can be distinguished from Asian populations, predominantly in this last the groove and pit forms.

TABLE 2. Frequencies of nonmetric dental traits[1]

Tooth	Trait	Total Frequency (left side)	Males	Females	U test P Value	Bilateral Symmetry Left	Bilateral Symmetry Right
um2	Carabelli trait	15	16	14	0.951	15	16
UM1	Carabelli trait	42	42	42	0.952	42	40
lm2	Protostylid	1	0	2	0.239	1	0
LM1	Protostylid	4	4	4	0.407	4	5.1
lm2	Groove pattern Y	81	80	82	0.731	81	72
lm2	Groove pattern +	17	16	18	0.731	17	26
lm2	Groove pattern X	2	4	0	0.731	2	2
LM1	Groove pattern Y	41	54	28	0.009	41	39
LM1	Groove pattern +	59	46	72	0.009	59	54
LM1	Groove pattern X	0	0	0	0.009	0	7
lm2	Cusp 6	12	16	8	0.025	12	8
lm2	Cusp 7	24	28	20	0.103	24	20
LM1	Cusp 6	4	3	5	0.320	4	4
LM1	Cusp 7	19	22	16	0.084	19	17

[1]The Mann-Whitney U test assessed sexual dimorphism based on just left sides.

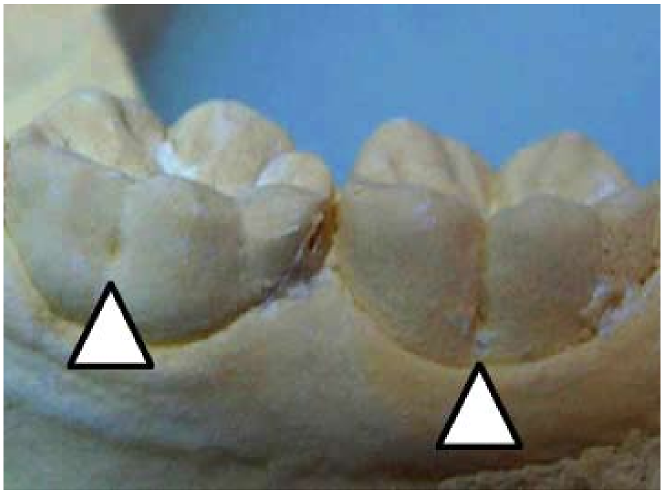

Fig. 4. Protostylid pit expression in primary second molar (Lm2) and permanent first molar (LM1).

Fig. 5. Groove pattern Y5 on primar second molar (Lm2) and +5 on permanent first molar (LM1).

Studies from India (Kannapan and Swaminathan, 2001) and Saudi Arabia (Salako and Bello, 1998) show the relationship of the frequency, bilaterally and absence of sexual dimorphism between temporary and permanent teeth. Pinkerton *et al*. (1999) observed Carabelli trait in both dentitions in 245 pairs of monozygotic and dizygotic Australian Caucasoid twins, finding little influence of sexual dimorphism on the primary or permanent dentition. Their findings showed that some traits (like Carabelli) of the primary dentition exhibited considerable genetic control and, thus, little alteration by the environment.

The frequency of the Carabelli trait is highest in Caucasians and lower in other populations, though American Negroes show relatively high frequencies of this trait compared to Japanese, Ainu and Pimas, and the cusp is practically absent in Eskimos (Hanihara, 1976). Moreno *et al*. (2004) and Moreno and Moreno (2005) report the Carabelli trait frequency to be 40.5%.

In the present study, Carabelli's trait is sexually dimorphic; it is expressed bilaterally; and the furrow and pit forms predominate over the tubercle and cuspid forms in both the primary and permanent dentition, suggesting that there is ambivalence in the population discrimination of this trait. The association of the trait between the dentitions may suggest a strong genetic control for its expression (Tables 4 and 5).

Protostylid

The protostylid has been defined as an "American feature" due to the occurrence of high frequencies in the European, African and Asian populations of the

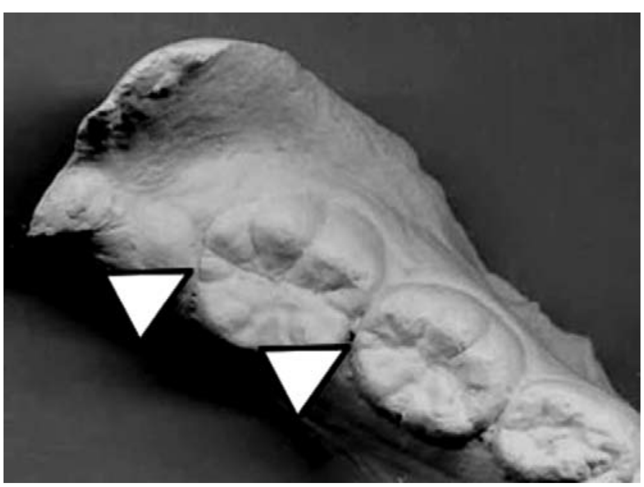

Fig. 6. Cusp 6 on primary second molar (Lm2) and permanent first molar (LM1).

Fig. 7. Cusp 7 on primary second molar (Lm2) and permanent first molar (LM1).

Americas, and to the particularly high prevalence of the foramen cecum in American populations (Rodríguez, 1999, 2004). Robbins (1998) indicated that the fossa or pit forms (foramen cecum) of the protostylid prevail over the cuspal form in the primary and permanent dentitions. Hanihara (1976) found that cusp forms of the protostylid were found in low frequency in most populations, rarely occurring in modern human groups, notably Asians. This led him to note that this trait is useful for differentiating the Mongoloid dental complex of the Caucasoid and Negroid. In primary teeth, it is common to find the fossa form of the protostylid, but the trait rarely reaches the height or size of a cusp.

In the deciduous dentition, the protostylid is frequently observed on the mandibular second molars. Frequencies of this trait seem to be highest in Eskimos and the Pima, and relatively low in Japanese and Ainu. In Caucasians and American whites, it was seldom observed (Hanihara, 1966, 1976). Moreno *et al*. (2004) and Moreno and Moreno (2005) found a frequency of this feature in permanent teeth of 1.5%, with a high frequency of the Point P. The population observed in this study presents a retention of the Amerindian dental complex, evidenced by the high frequency of the grade 1, which is the fossa or pit in the buccal developmental groove that separates the mesiobuccal and distobuccal cusps (Tables 4 and 5).

Groove pattern

This trait is defined by the basic arrangement of grooves and cusps of the occlusal surface of deciduous and permanent molars (Hillson, 1996). Smith *et al*. (1987) analyzed children from five ethnic groups, concluding that there are no significant differences between expressions of the groove pattern between the first permanent molar and the second primary molar, with the Y pattern occurring most frequently. A study of children with Caucasoid characteristics from India (Kaul and Prakash, 1981) reported the common occurrence of the pattern Y in primary and permanent teeth, the same as in an Eskimos from Alaska (Hasund and Bang, 1985). This trait characterizes the occlusal surface of the low molars by means of a contact pattern of the cusps, that can be configured in the Y, + or X forms. Y is the ancestral pattern considered as present, while X and + configurations are reductions or absences (Scott and Turner, 1997), frequently observed in Caucasoid groups. The temporary mandibular second low molars show a bigger tendency to the configuration Y.

In this study the behavior of the intercusp contact furrows was given by the Y pattern or “ Dryopithecus “ for the primary lower second molars and + or a “cross-like structure” for the permanent lower first molars; this can be due to that the primary dentition present a stronger genetic control, for what the Dryopithecus pattern native of the last Asian populations have conserved. In the case of the permanent first molars, it is assumed that the miscegenation processes mark a tendency toward the + pattern, which is a characteristic of the Caucasoid populations. In both dentitions, bilateral symmetry is observed in trait expression, but sexual dimorphism is not discernible.

In most publications, the groove pattern and the number cusp have been described together, for example Y5 or +4, although the number of cusps varies independently of the groove pattern (Mayhall, 2000). In the present sample, the Y5 configuration was observed in the deciduous second low molar which is a characteristic of Mongoloid and African populations. In the permanent first low molar prevailed +5 configuration, characteristic of Caucasian and hybrid European groups (Rodríguez, 2003) (Tables 4 and 5).

Cusp 6

The sixth cusp is known as the *tuberculum accessorium posteriore internum* (Mayhall, 2000). Hanihara (1966, 1976) shows that this feature is an accessory cusp, and, when it appears, it is located between the distolingual and the distobuccal cusps of the primary and permanent mandibular molars. The incidence of this cusp, in primary and permanent dentitions, has been studied by several researchers, and it has been described as a racial characteristic of Mongoloid populations.

Frequencies of cusp 6 also show a distinct contrast between populations. The expression of this trait occurs fairly commonly in Japanese, Ainu, and the Pima. Similar results are observed in the primary dentition (Hanihara, 1976). In one study, the frequency of this characteristic was 5% (Moreno *et al*., 2004; Moreno and Moreno, 2005) (Tables 4 and 5).

Cusp 7

This is another accessory molar cusp, and it is located at the marginal border between the mesiolingual and distolingual cusps. It was originally described using the term *tuberculum accessorium mediale internum*, and many occurrences have been reported by several authors in the fossil and recent primates including man. Among the permanent and deciduous mandibular molars of recent man, American blacks show the highest frequency, which distinguishes blacks from other populations. In primary mandibular second molars, the difference in frequencies of this character is much greater (Hanihara, 1976). Moreno *et al.* (2004) and Moreno and Moreno (2005) observed that the frequency of this characteristic to be 25% on permanent molars in a racially mixed population (Tables 4 and 5).

In overview, (1) the high frequency of the groove and fossa forms of Carabelli trait, (2) the high frequency of the protostylid grade 1 (foramen cecum), (3) the low frequencies of cusps 5 and 6, and (4) the expression of the molar groove pattern and number cusp collectively

TABLE 3. Three nonmetric trait frequencies in the primary and permanent dentitions

Trait	Deciduous Grade	Deciduous Percent	Permanent Grade	Permanent Percent
Carabelli trait	0	3	0	31
	1	82	1 - 4	55
	2 - 4	15	5 - 7	14
Protostylid	0	6	0	19
	1	93	1	76
	2	1	2 - 7	5
Groove pattern	Y	81	Y	41
	+	17	+	59
	X	2	X	0
Cusp 6	0 - 1	88	0 - 1	96
	2 - 5	12	2 - 5	4
Cusp 7	0	76	0	81
	1 - 3	24	1 - 4	19

suggest that the sample has received influence of the Mongoloid and Caucasoid dental complexes. This inference agrees with the studies of Moreno *et al*. (2004), Moreno and Moreno (2005), León and Riaño (1997), Herrera and Osorno (1994), Turner (1984, 1990), Sciulli (1998) and Hanihara (1966, 1968) who affirm that all indigenous American groups exhibited a Sinodont pattern of dental morphology (*i.e*., Mongoloid dental complex subdivision of NE Asia). It is supposed that this pattern has persisted since the original immigrants from Asia peopled the Americas by way of Beringia. Subsequently, the Colombian historical development is such that the dental morphology of the current populations is the reflection of hybridization among Mongoloid (pre-Hispanic indigenous), Caucasoid (Spanish conquerors) and African (African slave) ethnic groups. As such, the sample observed in this study can be considered a hybrid group composed primarily from

TABLE 4. Frequency of nonmetric dental traits in permanent dentition

Samples	Carabelli trait	Protostylid	Groove pattern	Cusp 6	Cusp 7
Japanese[a]	6.5	6.6	26.0 (+)	25.3	6.7
Pima[a]	6.9	19.4		26.6	8.2
Eskimo[a]	13	28.6	20.1 (Y)	50	20
Caucasian[a]	39	0	59.5 (+)	5.2	5.1
American blacks[a]	16.3	0	49.0 (+)	6.5	46.3
Sinodonty[b]	32.1	34.7	10.9 (Y)	47.8	9.8
Sundadonty[b]	30.6	30	19.6 (Y)	35.5	7.4
North American Indian[b]	35.6	41.9	8.1 (+)	49.2	10.2
South American Indians[b]	41.9	29.8	9 (+)	55.8	9.6
Thailanders[c]	26.6	20.4	71.8 (Y); 25.6 (+)	17.1	2.4
American caucasoid[d]	45	0	84.1 (+)	5.2	5.1
Colombian Living Indians	20 - 90	0 - 60	-	0 - 80	0 - 80
Páeces (Colombian Indians)[e]	0.6	0.2	-	-	38
Guambianos (Colombian Indians)[e]	0.2	0.1	-	-	-
Emberá (Colombian Indians)[e]	60	20	-	-	-
Obando pre-Hispanic[f]	50	10	51.6 (Y) - 31 (+)	38.9	-
Bogotá racially mixed[g]	28	4	-	-	-
Cali racially mixed[h]	40.5	1.5	-	5.0	25.0
Present study	50.0	4.0	41 (Y) - 59 (+)	4.0	19.0

[a]Hanihara (1976, 1992), [b]Turner (1984, 1990), [c]Manabe *et al*. (1997), [d]Rodríguez JV (1999, 2003), [e]León and Riaño(1997), [f]Rodríguez (2002), [g]Herrera and Osorno (1994); [g]Moreno *et al*. (2005).

TABLE 5. Percentages of nonmetric dental traits in the primary dentition

Sample	Carabelli trait	Protostylid	Groove pattern	Cusp 6	Cusp 7
Japanese[a]	11.9	47.7	-	36.9	73.7
Eskimo[a]	13	28.6	-	37.7	79.4
Caucasian[a]	35.7	14.5	-	7.3	40.7
American Negroes[a]	11.8	19.1	-	12	46.8
Modern Japan[b]	11.5	53.8	-	33.3	87.0
Pima[c]	5.1	80.8	88.7 (Y)	36.8	70.8
Hindus[d]	66.1	-	-	-	-
Saudi Arabia[e]	58.7	-	-	-	-
Present Study	15.0	1.0	81.0 (Y); 17.0 (+)	12.0	24.0

[a]Hanihara (1976), [b]Kitagawa (2000), [c]Tochieri (2002), [d]Joshi (1975) and [e]Salako and Bello (1998)

Mongoloid and Caucasoid complexes (Tables 4 and 5).

CONCLUSIONS

The data presented here suggest, based on the NDCT studied, that dm2 is more conservative in form than the permanent M1. The morphological similarities between the two teeth are well established with regard to the frequencies of Carabelli trait, protostylid, molar cusp pattern, and cusps 6 and 7.

There is correspondence in the expression of the Carabelli trait and the protostylid between the primary and permanent dentitions, which implies a strong genetic control in its frequency and variability. In the case of the molar groove pattern, more investigations should be carried out on other Colombian groups with increased sample sizes to better analyze the behavior of this feature among the two dentitions. Sexual dimorphism does not exist and bilateral symmetry is observed in the expression of the five NDCT studied in th deciduous and permanent dentitions. The data presented in this research indicate, based on the NDCT studied, that dm2 is more conservative in form than M1.

According to the frequency and variability of the NDCT studied, it is indicated that the dental morphology of the sample constitutes a mix of the Mongoloid and Caucasoid dental complexes, which is reflected in the intermediate expressions of Carabelli trait. The high frequency of the the pit form (grade 1) of the protostylid suggests that it is a genetic conservation of the Amerindian dental complex as a result of the historical processes of peopling, distribution and establishment of the pre-Hispanic human groups and admixture after the arrival of the Europeans to the New World. The high expression of cusp 7 in grades 1 and 2 suggests an influence of the Negroid dental complex.

Studies should be carried out on the frequency and variability of other NDCT to increase interpopulation information and better characterize the dental morphology, not just of mixed populations with Caucasian characteristics, but also of the Afro-American and indigenous communities of the region, in order to better understand how information from the teeth inform us about the micro-evolutionary aspects, displacements, contacts, isolations and historical process on the Colombian population.

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APPENDIX. Trait descriptions

Tooth, Trait	Code	Grade	Reference
Primary upper second molar, Carabelli's trait	Um2	0. Absent 1. U or Y-shaped depression 2. Two parallel furrows 3. Small cusp 4. Free cusp	Grine (1986)
Permanent first upper molar, Carabelli's trait	UM1	0. Smooth surface 1. Groove present 2. Pit present 3. Small Y-shaped depression 4. Large Y-shaped depression 5. Small cusp 6. Medium cusp 7. Free cusp	ASUDAS Turner *et al*. (1991)
Primary second mandibular molar, protostylid	Lm2	0. Absent 1. Pit or furrow 2. Cuspid	Sciulli (1998)
Permanent first lower molar, protostylid	LM1	0. Smooth surface 1. Pit present 2. Buccal groove curve distal 3. faint groove extending mesial from the bucal groove 4. Groove more pronounced 5. Groove stronger 6. groove extend across the buccal surface 7. Free cusp	ASUDAS Turner *et al*. (1991)
Primary second lower molar, groove pattern	Lm2	+. Cusp 1,2,3 and 4 are in contact X. Cusp 1 and 4 are in contact Y. Cusp 2 and 3 are in contact	Sciulli (1998)
Permanent first lower molar, groove pattern	LM1	Y. Cusp 2 and 3 are in contact +. Cusp 1,2,3 and 4 are in contact X. Cusp 1 and 4 are in contact	ASUDAS Turner *et al*. (1991)
Primary second lower molar, cusp 6	Lm2	0. Absent 1. Cusp 6 << cusp 5 2. Cusp 6 < cusp 5 3. Cusp 6 = cusp 5 4. Cusp 6 > cusp 5 5. Cusp 6 >> cusp 5	ASUDAS Turner *et al*. (1991)
Permanent lower first molar, cusp 6	LM1	0. Absent 1. Cusp 6 << cusp 5 2. Cusp 6 < cusp 5 3. Cusp 6 = cusp 5 4. Cusp 6 > cusp 5 5. Cusp 6 >> cusp 5	ASUDAS Turner *et al*. (1991)
Primary second lower molar, cusp 7	Lm2	0. Absent 1. Through trace 2. Small cusp 3. Well developed	Hanihara (1961)
Permanent lower first molar, cusp 7	LM1	1. Faint cusp (two weak grooves) 1A. Fine cusp without free apex 2. SmalL cusp 3. Medium-sized cusp 4. Large cusp	ASUDAS Turner *et al*. (1991)