ANIL AGGRAWAL'S
Internet Journal of Forensic Medicine and Toxicology
The world's first online journal devoted entirely to forensic medicine and toxicology · Published 1 January and 1 July

VOL. 13, NO. 1 · JANUARY – JUNE 2012
Downloaded from www.anilaggrawal.com · ISSN 0972-8074 (Online) · https://www.anilaggrawal.com/ij/vol_013_no_001/papers/paper001.html

Prevalence of Developmental Dental Anomalies : A study of Punjabi Population

Pooja Malik[1], Gagandeep Singh[2], Rakesh Gorea[3], Om Prakash Jasuja[2]

[1]Amity Institute of Forensic Sciences, Amity University, Noida, India
[2]Department of Forensic Science, Science Block No.1, Punjabi University, Patiala, India
[3]Professor, Department of Forensic Medicine, Gayan Sagar Medical College, Ram nagar, Patiala, India
Contact: Om Prakash Jasuja · opjasuja@gmail.com

CITE THIS ARTICLE

Malik P, Singh G, Gorea R, Jasuja OP. Prevalence of Developmental Dental Anomalies : A study of Punjabi Population. *Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology* [serial online], 2012; Vol. 13, No. 1 (January – June 2012): [about 21 p]. Available from: https://www.anilaggrawal.com/ij/vol_013_no_001/papers/paper001.html

ABSTRACT

The primary objective of the study was to elucidate the prevalence of developmental dental anomalies in adults belonging to Jat Sikh and Bania population of Punjab state in India to generate statistical database. The study sample included 103 subjects including both males and females in the age group of 18 to 35 years. Prepared dental casts were studied of all the individuals for prevalence of dental anomalies such as carabelli's trait, protostylid, shovelling, talon cusp, dens evaginatus etc. for ascertaining the frequency of these anomalies in population groups under study. Occurrence rate of each dental anomaly was calculated as percentage of total sample size under study. Inter and intra population differences in the prevalence rates of anomalies were also observed through existing literature. Carabelli's trait showed maximum prevalence in both Jat Sikh and Bania population in the present study. High frequency of macrodontia has been observed to be chractertsic of Jat Sikh population. Tooth transpositions, twinning of teeth, supernumerary teeth and dens evaginatus was found to be absent in both the populations. Males showed higher rates of dental anomalies as compared to females in majority of cases.

Keywords: Forensic, Personal identification, Dental anomalies, Population studies, Punjab, India

Introduction

Personal identification in crime scene investigations is achieved by parameters like visual acquaintance, physiognomic factors including fingerprints, DNA etc. Advanced decomposition of the dead body may be encountered in cases of mass disasters, burial, submersion etc. In such cases, comparative dental analysis play a major role in identification since tooth and the supporting

tissues have appreciable resistance against ambient factors (Petju et al., 2007). Identification through dental evidence involves comparison of the postmortem data with available antemortem records (including radiographs) (Pretty and Addy, 2002) and antemortem population databases containing information about dental characteristics like developmental dental anomalies.

Dental anomalies can be defined as craniofacial abnormalities of form, function, or position of the teeth, bones, and tissues of the jaw and mouth (Krapp and Cengage, 2002). These can include malformations, alterations in number of teeth, inherited disturbances and oral environmental changes during teeth development etc. Anomalies could be caused by genetic factors (inherited or mutagenic), environmental factors (infections, physical injuries, hormones, maternal diseases and defects, drugs and chemicals like antimetabolites, thiadiazole etc.) (Shafer et al., 2001). Low incidence and prevalence levels for such anomalies make them suitable to assist in personal identification cases (Thesleff, 2006).

Supernumerary teeth and hypodontia are among the commonest of dental developmental disorders which have been used for identification purposes (Pretty and Sweet, 2001). Dental anomalies have been found to express themselves to several degrees and different frequencies between different human populations and act as effective tool for comparing and characterizing the same (Palomino et al., 1977). Studies have reported significant intra region and inter region morphological variations in majority of dental traits among major population groups of the world. These variations are more pronounced in case of Asian populations which points towards complex population history and extent of migration (Hanihara, 2008). Also, it is commonly accepted that dental characteristics, such as size, shape, presence, number of cusps, and the size of the dental arches, are genetically determined (Goose and Lee, 1971). For this reason, the above mentioned characteristics differ among races and species and can constantly alter due to natural selection and the genetic changes (Mavrodisz et al., 2007). Therefore, study of the morphological properties of the dental structures could aid in phylogenic and genetic studies including gathering information about intra and inter species variations.

Talking in Indian context, few studies relating to dental anomalies have been reported in the literature (Reddy, 1985) in spite of the immense variation present in Indian population. More studies are required to generate population characteristics (dental anomalies) databases which could be used for identification purposes. Therefore, present study has been undertaken to establish the prevalence of certain developmental dental anomalies amongst the Jat Sikh and Bania population of Punjab State, India.

Materials and Methods

In the present study, dental anomalies were studied in the permanent dentition of Jat Sikh and Bania population of Punjab State .

What is already known on this topic

In Indian context,few of such studies have been reported in the literature by authors :Ganguli,1960; Lukacs,1977,2001; Bhasin et al, 1979; Prakash et al,1979; Rami Reddy et al,1981, Kulkarni et al, 1985. These studies focus on the prevalence of various Dental Anomalies in various populations(Indian).

What This study adds

The above mentioned studies have been mainly conducted on Central and South Indian populations.The present study has been conducted on Jat Sikhs and Bania population of Punjab State. To the best of our knowledge, No such study has been reported in literature on the above said population.

Suggestions for further development

This study may be undertaken on a larger scale by including other population of the state as well as country and increasing the sample size.This will provide a database of the different dental anomalies in different ethnic groups and populations and may also help in personal identification and help in tracing the family lines in case of hereditary anomalies.

Jat Sikhs are large ethnic group of people who are native mainly to the Punjab region of Northern India and Pakistan and considered to be the merged descendants of Indo-Scythian tribes that entered the Punjab and first occupied the Indus valley as far down as Sindh (presently in Pakistan) (Singh S (1989) Punjab–an overview, unpublished work). *Bania* population constitutes large and enterprising community of India including several business sub-communities (Gupta, 1975).

A total number of 103 subjects were studied (Jat Sikh males: 28, females: 25, Bania males: 25, females: 25). The subjects belonged to various areas of Punjab and were in age group of 18 to 35 years. The intra-oral examination, past dental history and impressions were recorded for the study. Alginate Impression material (Heraplast, Heraeus Kulzer group, Germany) was used for making dental impressions. The water to powder ratio was kept constant at 8g to 20.5 ml of water as per manufacturer's instructions on the packet. Permanent dental casts were made out of the recorded impressions using dental stone (Gypstone superhard Dental stone Type III, Prevest Denpro Limited, India). The water to powder ratio was kept constant at 30 cc/100gms as per manufacturer's instructions on the packet. Afterwards, various developmental dental anomalies were observed. Occurrence rate was calculated in terms of percentage with respect to total sample size under study. Photography was done using digital camera (Canon IXUS 700, Japan).

Anomalies studied

In humans, tooth development starts at 13.73 weeks for females and 15.75 weeks for males for maxillary incisors, and 14.11 weeks for females and 17.41 weeks for males for mandibular teeth of the intrauterine life (Sema Aka et al., 2009). Different anomalies are associated with different developmental stages e.g. anomalies of number such as absence or presence of teeth are linked to initiation stage, anomalies of size and proportion with proliferation stage, anomalies of structure with histodifferentiation stage, anomalies of shape with morphodifferentiation stage and compositional anomalies with apposition stage (Sharawy and Bhussry,1990; Garant, 2003).

Following anomalies were studied in the present study:

(a) *Carabelli trait or cusp* is a morphological anomaly located on mesial palatal surface of the first upper permanent molars and is rarely observed on second or third permanent molars (Alvesalo et al., 1975).

(b) *Protostylid* is an elevation or ridge of enamel on the anterior part of the buccal surface of the lower molars ascending from the gingival end of the buccal groove and extends mesio-occlusally (Dahlberg, 1950) and exhibits poor and varied expressivity (Gaspersic, 1997).

(c) *Shovel trait* is a combination of concave lingual surface and elevated marginal ridges enclosing a central fossa in the upper central incisor teeth can be either absent or present and if present, can be wide ranging in expression (Hsu et al., 1999) .

(d) *Talon cusp* (dens evaginatus of the anterior incisors) is a rare dental anomaly that indicates accessory cusp like structure projecting from cingulum area or cementoenamel junction of maxillary lateral or central incisors, occurring predominantly in permanent dentition (Ferraz et al., 2001) .

(e) *Tuberculum intermedium* is described as a cusp or cuspule occurring in the lingual groove between the metaconid and entoconid of the lower molars and also known as cusp 7 or interconulid or metaconulid or C7 (Turner et al., 1991).

(f) *Dental transposition* is described as the positional interchange between two adjacent teeth or development or eruption of tooth in a position normally occupied by the adjacent teeth (in unilateral or bilateral way) (Peck et al.,1993).

(g) *Dental diastema* has been described as spaces between some or all the teeth in the dental arch, also known as midline diastema in case of central incisors (Steigman and Wiessberg, 1985).

(h) *Tooth agenesis* of human dentition is clinically and genetically heterogenous condition described as the congenital lack of one or more deciduous or permanent dentition e.g. *oligodontia* (absence of six or more permanent teeth), *hypodontia* (absence of less than six teeth), *anodontia* (absence of all the permanent and deciduous dentition) (Stevenson and Hall, 2006).

(i) *Supernumerary teeth* condition is defined by the presence of additional teeth in the dental arch in addition to normal dentition (Garvey et al., 1999).

(j) *Microdontia (Localized form is also known as Peg shaped anomaly*) associated with the various types of teeth involves a conical crown -size reduction i.e. reduction in the diameter from the cervix to incisal edge (Bot and Salmon, 1977).

(k) *Macrodontia* involves larger tooth size that it's contralateral homolog, causing crowding of teeth or taking more than its designated space in the dental arch. Microdontia is contrary anomaly to the macrodontia and involves teeth which are smaller in size than the normal (Stevenson and Hall, 2006).

(l) *Fusion* is commonly observed as the union of two distinct dental sprouts which could occur at any stage of tooth development (pulp chambers and canals may be linked or separated). The prevalence of fusion in permanent dentition is approximately 0.2% (Grover et al., 1982) whereas cases of bilateral fusion are less frequent than unilateral fusion (Neves et al., 2002).

(m) *Gemination* includes partial development of two teeth from one single tooth germ and its completed form is known as *twinning* (Slootweg, 2007).

Observational parameters of all the anomalies used to distinguish between the carriers and non-carriers of the traits have been illustrated in *table-1* .

Table 1. Dental anomalies observed during the present study and criteria used to distinguish the carriers of these traits from the non-carriers

S.No	Dental Trait	Grades of Expression	Type of tooth/ teeth
1.	Carabelli's Trait (Grine, 1986)	1 Pit, groove present 2 Two grooves, roughly parallel 3 Welt: area between grooves raised, cusp apex not free 4 Cusp: area between grooves raised, cusp apex free	First, second and third maxillary molars
2.	Protostylid (Grine, 1986)	0 Absent, mesiobuccal surface smooth and buccal surface smooth and buccal groove present. 1 Groove, horizontal or oblique fissure present 2 Cusp, Fissure(s) delineate swelling with free apex	First, second and third mandibular molars
3.	Shoveling (Hanihara, 1963)	0 Absent lingual surface smooth 1 Semi-shovel: slight elevation of the marginal ridges 2 Shovel: marginal ridges easily seen 3 Strong shovel: marginal ridges broad and high.	Central and Lateral Incisors, Canines
4.	Talon Cusp (Hattab et al., 1996)	Type 1 A well defined cusp on the palatal surface of the incisors; it covers at least half of the distance between the incisal edge and the cemento enamel junction (CEJ). Type 2 The cusp covers less than a half of the distance between the incisal edge and the CEJ but is larger than 1 mm. Type 3 A small tubercle on the gingival third of the tooth can be T, Y or V shaped.	Incisors (Maxillary and mandibular)
5.	Tuberculum Intermedium (Metaconulid/C7) (Turner et al., 1991)	0 Absent 1 Hypoconulid >> C7 2 Hypoconulid > C7 3 Hypoconulid = C7 4 Hypoconulid < C7 5 Hypoconulid << C7 Whereas C stands for Cusp	Molars (mandibular)
6.	Dental Transposition (Peck and Peck, 1995)	1 Maxillary canine-first premolar (Mx.C.P1) 2 Maxillary canine-lateral incisor (Mx.C.I2) 3 Maxillary canine to first molar site (Mx.C to M1)	Mostly involving incisors and canines

S.No	Dental Trait	Grades of Expression	Type of tooth/ teeth
		4 Maxillary lateral incisor-central incisor (Mx.I2.I1)	
7.	Midline Diastema (Keen, 1963)	Spacing more than 0.5mm between proximal surfaces of two central incisors were labeled as midline diastema.	Central incisors
8.	Tooth Agenesis (Stevenson and Hall, 2006)	Anodontia/ Hypodontia/Oligodontia	Various types of teeth
9.	Supernumerary Teeth (Garvey et al., 1999)	Presence of additional teeth in the dental arch in addition to normal dentition	-
10	Microdontia (a) Localized (Bot and Salmon, 1977) (b) Generalized (Shafer et al., 2001)	Reduction in the diameter from the cervix to incisal edge All the teeth are smaller than the normal	Mainly lateral incisors Various types of teeth
11.	Macrodontia (a) Localized (Bot and Salmon, 1977) (b) Generalized (Shafer et al., 2001)	Involves larger tooth size that it's contralateral homolog All the teeth are larger than the normal	Mainly incisors
12.	Fusion (Neves et al., 2002)	Union of two distinct dental sprouts	Incisors (Maxillary and mandibular)
13.	Germination (Slootweg, 2007)	Division of single tooth germ by invagination	Various types of teeth

Results and Discussions

Comparison between frequency of anomalies between Jat Sikh and Bania populations (*Table 2*) revealed that both the populations had high percentage of Carabelli's trait followed by localized and generalized macrodontia **.** Population wise frequency details have been given in the following paragraphs,

Table 2. Comparison of Dental Anomalies in Jat Sikhs and Bania Population

S.No.	Anomaly Studied	Jat Sikhs*			Banias*		
		Frequency (%)	SD	SEM	Frequency (%)	SD	SEM
1.	Carabelli Trait	71.4(52)	0.72(0.103)	0.136(0.021)	68(52)	0.69(0.103)	0.138(0.021)
2.	Protostylid	0(4)	0(0.04)	0(0.008)	12(8)	0.12(0.080)	0.024(0.016)
3.	Shoveling	3.6(4)	0.036(0.04)	0.006(0.008)	0(8)	0(0.08)	0(0.016)
4.	Talon Cusp	0(0)	0(0)	0(0)	4(0)	0.04(0)	0.008(0)
5.	Tuberculum Intermedium	7.1(4)	0.07(0.04)	0.01(0.008)	0(0)	0(0)	0(0)
6.	Dental Transposition	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
7.	Dental (Midline) Diastema (a)*Maxillary* (b)*Mandibular*	7.1(8) 3.6(4)	0.071(0.08) 0.036(0.04)	0.01(0.016) 0.005(0.008)	16(4) 0(0)	0.16(0.04) 0(0)	0.032(0.008) 0(0)
8.	Tooth agenesis (Hypodontia)	3.6(0)	0.036(0)	0.006(0)	0(4)	0(0.04)	0(0.008)
9.	Supernumerary Teeth	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
10.	Microdontia (a) *Localized* (b) *Generalized*	7.1(4) 0(4)	0.07(0.04) 0(0.04)	0.01(0.008) 0(0.008)	0(4) 8(0)	0(0.04) 0.08(0)	0(0.008) 0.016(0)
11.	Macrodontia (a) *Localized* (b) *Generalized*	10.7(16) 17.9(16)	0.1(0.16) 0.18(0.16)	0.01(0.032) 0.03(0.032)	0(8) 8(8)	0(0.08) 0.08(0.08)	0(0.016) 0(0.016)
12.	Fusion	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
13.	Gemination	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table legends

SD: Standard Deviation

SEM: Standard Error of Mean

* Values for females in parenthesis

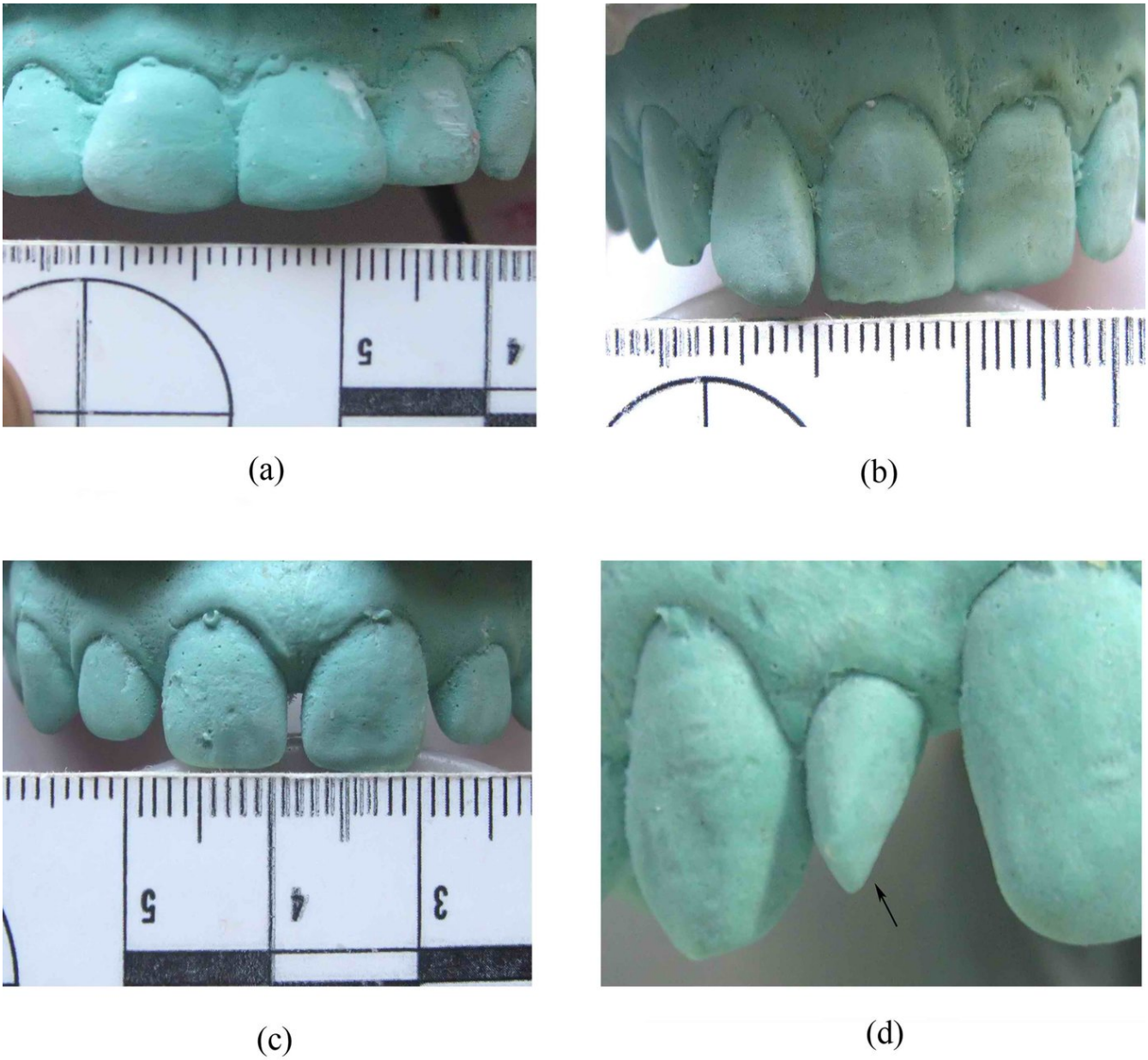


Figure 1 Illustration of different types of dental anomalies (Macrodontia and Microdontia)

(a) Relative generalized macrodontia, (b) Localized macrodontia,
(c) Relative generalized microdontia, (d) Localized microdontia (Peg Lateral)

Figure 1.

Jat Sikh Population

In Jat Sikhs, the most common developmental trait was found to be Carabelli's trait (males: 71.4%, females: 52%). Relative generalized macrodontia (*figure 1a*) was found to be 17.9 % in Jat Sikh males and 16% in their female counter parts while localized macrodontia involving maxillary incisors (*figure 1b*) was 10.7% in males and 16% in the case of females. The prevalence of relative generalized microdontia (*figure 1c*) was found to be 7.1% in Jat Sikh males and 4% in case of Jat Sikh females while that of localized microdontia (*figure 1d*) was found to be absent in Jat Sikh

males and frequency of prevalence was 4% in case of Jat Sikh females. Tuberculum intermedium was evident in the Jat Sikh population with frequency of 7.1% in the case of males and 4% in the case of females. The dental transpositions, twinning of teeth (fusion and gemination), supernumerary teeth and talon cusp were found to be absent in Jat Sikh population (both males and females).

Bania Population

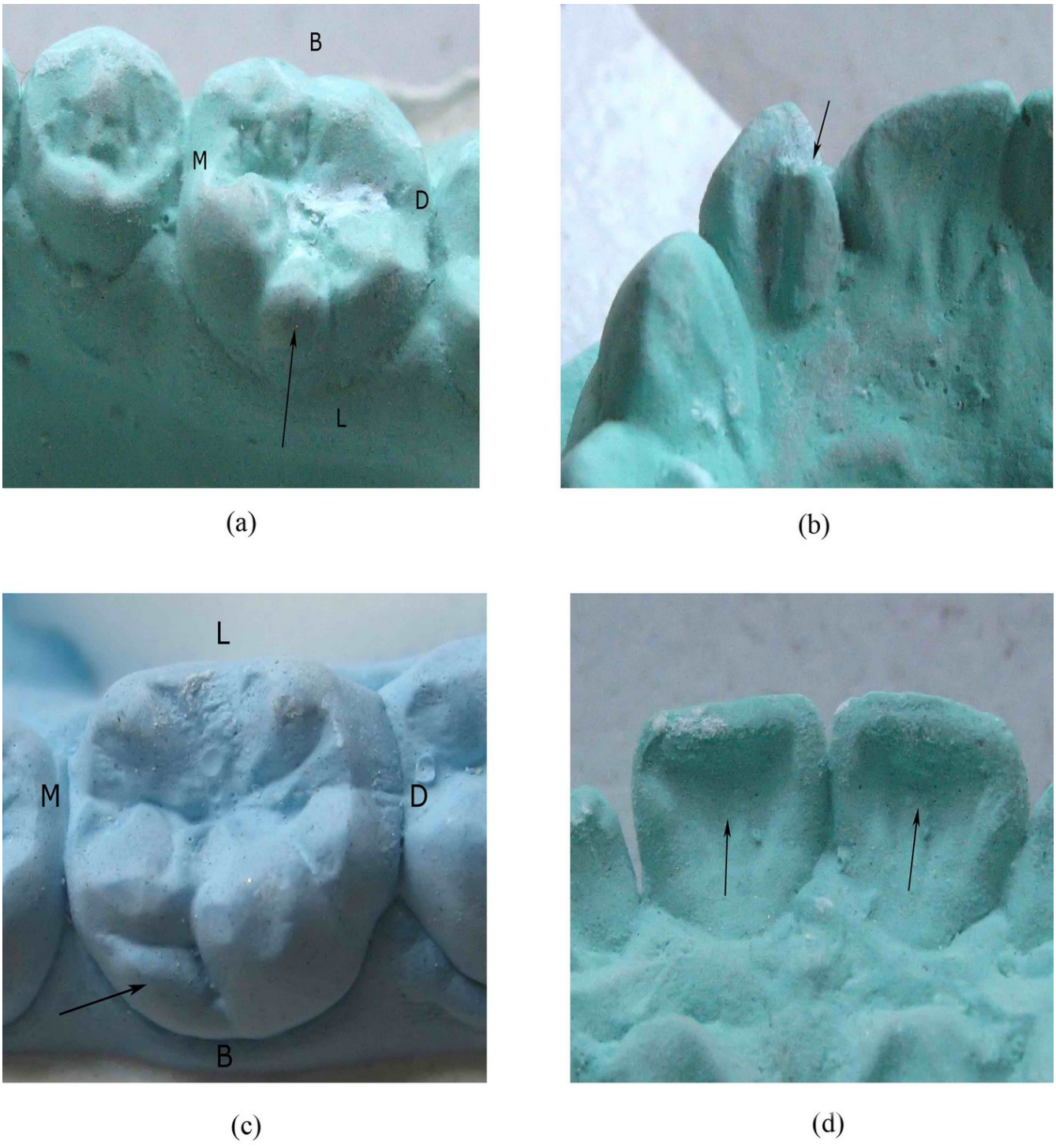


Figure 2 Illustration of different types of dental anomalies (Tuberculum intermedium, Talon cusp, Protostylid, Shoveling)

(a) Tuberculum intermedium (b) Talon cusp (c) Protostylid (d) Shoveling

Figure 2.

In case of Bania population also, most common developmental anomaly was found to be Carabelli's trait (*figure 2a*) with frequency of 68% in the males and 52% in females. A single case of talon cusp (*figure 2b*) was found in Bania male. The frequency of protostylid (*figure 2c*) was found to be 12%

in the case of males and 8% in females. The shoveling (*figure 2d*) was found to be absent in Bania males while frequency was 8% in Bania females. Prevalence of hypodontia (*figure 3a*) was found to be absent in Bania males and the frequency in case of females was found to be 4%. Tuberculum intermedium (*figure 3b*) was found to be absent in Bania males as well as females. The frequency of maxillary midline diastema (*figure 3c*) was found to be 16% in case of Bania males and 4% in case of females. Mandibular midline diastema (*figure 3d*) was found to be absent in both males and females. The tooth transpositions, twinning of teeth (fusion and gemination), Supernumerary teeth and Tuberculum intermedium were found to be absent in both Bania males and females.

(*Table 3*) illustrates comparative frequency data (including statistical) of prevalence of different dental anomalies in different populations and age groups including present study.

Table 3. Prevalence and Comparison of Various Dental Anomalies Reported in Different Populations including present study

S.No.	Population	Dental Anomaly	Frequency (%)	SD	SEM
1.	Karnataka, India (Reddy, 1983)	Carabelli's trait	29.2 (males)	na	na
	South Indian Males (Reddy, 1985)		na	0.10	0.003
2.	Southern Chinese, Hong Kong (Davis, 1987)	Hypodontia (without 3M)	6.9	0.069	0.02
3.	South Indian (Nainar and Gnanasundaram, 1989)	Midline Diastema (Maxillary)	1.6	0.016	0.00016
		Midline Diastema (Mandibular)	0.3	0.003	0.00003
4.	Malaysian (Rusmah, 1992)	Carabelli Trait	52.2	0.52	0.02
5.	Japanese Children (Yonezu et al., 1997)	Fusion	4.1	na	na
		Hypodontia	2.4		
		Peg Laterals	0.6		
		Supernumerary Teeth	0.1		
6.	Saudi Arabian Children (Salako and Bello,1998)	Carabelli's Trait	58.7	0.585	0.03
7.	Portuguese (Pinho et al., 2005)	Hypodontia	1.3	0.013	0.0001
8.	Turkish (Yilmaz et al., 2005)	Tooth Transposition	0.4	0.004	0.0005
9.	Sarajevo (Konjhodžić-Raščić et al., 2006)	Hypodontia	6	0.003	0.003
		Hyperdontia	1	0.01	0.0006
		Macrodontia	6	0.06	0.003
		Microdontia	5	0.04	0.002
10.	Turkish Population (Altug-Atac and Erdem, 2007)	Fusion	0.23	0.002	0.00003
		Gemination	0.07	0.0006	0.00001
		Microdontia	1.58	0.0158	0.0002
		Macrodontia	0.03	0.0003	0.000005
		Hypodontia	2.63	0.026	0.00047

S.No.	Population	Dental Anomaly	Frequency (%)	SD	SEM
		Hyperdontia	0.36	0.0035	0.000063
11.	Iran (Ezoddini et al., 2007)	Supernumerary Teeth	3.5	na	na
		Macrodontia	0.2		
		Fusion	0.2		
12.	Contemporary & Ancestral Hungarian (Mavrodisz et al.,2007)	Talon Cusp	48	0.48	0.019
			2.5	0.28	0.023
13.	Japanese Children (Goya et al.,2008)	Hypodontia	9.4	na	na
14.	Jat Sikhs, Punjab (present study)	Macrodontia (Localized)	10.7(16)*	0.1(0.16)	0.01(0.032)
		Macrodontia (Generalized)	17.9(16)*	0.18(0.16)	0.03(0.032)
		Microdontia (Localized)	7.1(4)*	0.07(0.04)	0.01(0.008)
		Microdontia (Generalized)	0(4)*	0(0.04)	0(0.008)
		Midline Diastema (Maxillary)	7.1(8)*	0.071(0.08)	0.01(0.016)
		Midline Diastema (Mandibular)	3.6(4)*	0.036(0.04)	0.005(0.008)
		Protostylid	0(4)*	0(0.04)	0(0.008)
		Carabelli's Trait	71.4(52)*	0.72(0.103)	0.136(0.021)
		Tuberculum Intermedium	7.1(4)*	0.07(0.04)	0.01(0.008)
15.	Banias, Punjab (present study)	Macrodontia (Localized)	0(8)*	0(0.08)	0(0.016)
			8(8)*	0.08(0.08)	0(0.016)
		Macrodontia (Generalized)	0(4)*	0(0.04)	0(0.008)
			8(0)*	0.08(0)	0.016(0)
		Microdontia (Localized)	16(4)*	0.16(0.04)	0.032(0.008)
		Microdontia (Generalized)	0(0)*	0(0)	0(0)
			12(8)*	0.12(0.080)	0.024(0.016)

S.No.	Population	Dental Anomaly	Frequency (%)	SD	SEM
		Midline Diastema (Maxillary)			
		Midline Diastema (Mandibular)	68(52)*	0.69(0.103)	0.138(0.021)
		Protostylid			
		Carabelli’s Trait			

*Frequency for females in parenthesis; **na: Data not available**

Higher percentage of Carabelli's trait could be clearly observed in south Indian males with frequency being 29.2% (Reddy, 1983), 52.2% in Malaysian population (Rusmah, 1992) and 58.7% in Saudi Arabian children (Salako and Bello, 1948). This observation goes with the fact that the frequency of carabelli's trait is quite high in Caucasian populations (Hsu et al., 1997) . Moreover, this trait is also regarded as distinguishing factor between Asian and Asian derived populations from European and African populations (Mizoguchi, 1985).

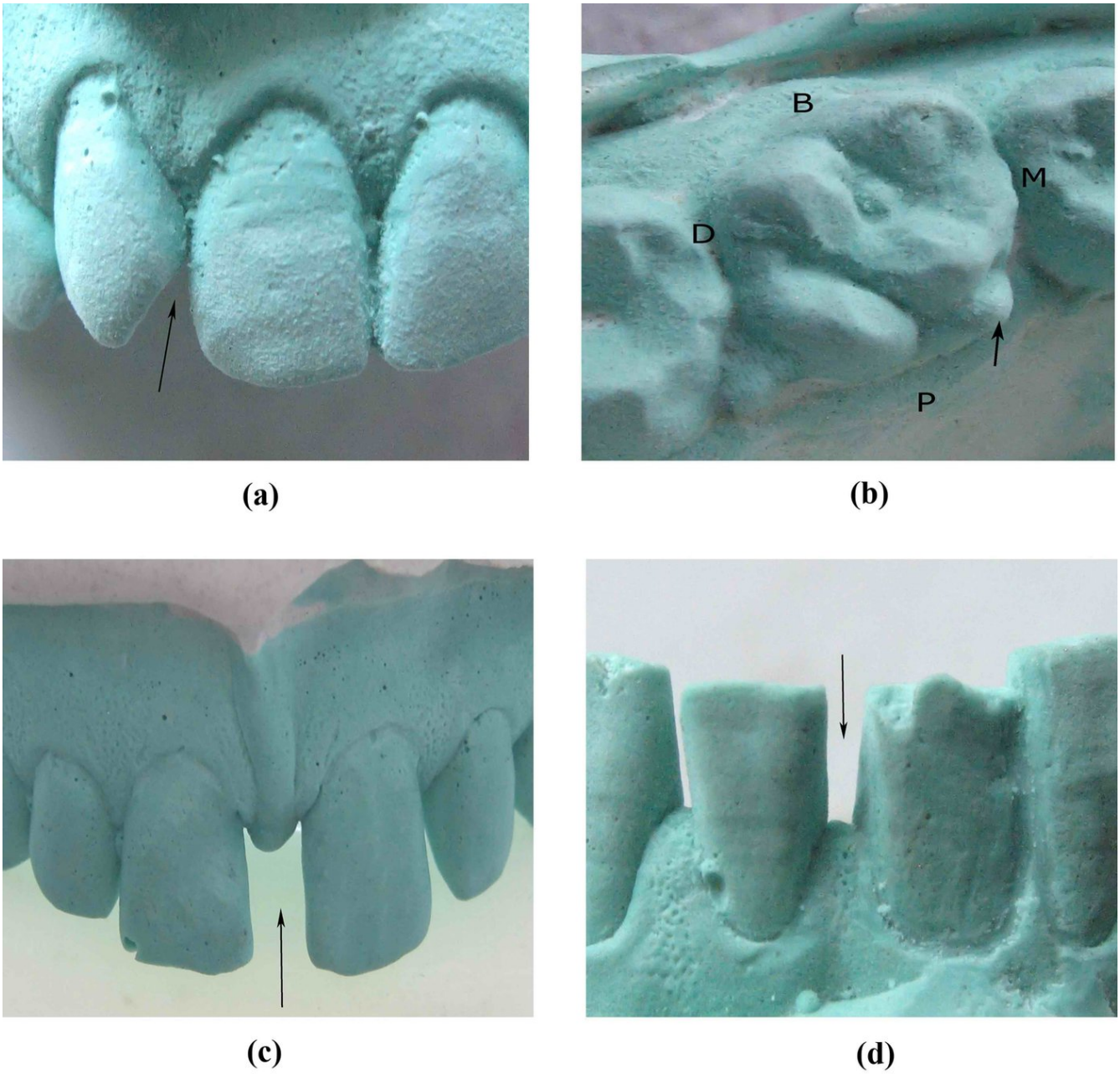


Figure 3 Illustration of different types of dental anomalies (Hypodontia, Carabelli's cusp, Diastema)

(a) Hypodontia (b) Carabelli's cusp
(c) Maxillary midline diastema (d) Mandibular midline diastema

Figure 3.

High percentage of macrodontia [localized 10.7% and generalized 17%] has been observed in Jat Sikh males as compared to other populations like Bania males [localized 0% and generalized 8%], 6% in Sarajevo (Konjhodžic-Rašcic et al., 2006), 0.03% in Turkish (Altug-Atac and Erdem, 2007) and 0.2% in Iranian population (Ezoddini et al., 2007) which could be regarded as considerably less.

Maxillary midline diastema showed high frequency in Bania and Jat Sikh populations (frequency being 16% and 7 %) as compared to its mandibular variant (frequency being 0 and 3.6). Also, this

frequency was more than that of observed in South Indian populations (frequency being 0.3%) (Nainar and Gnanasundaram, 1989).

Only a single occurrence of Talon cusp in Bania population reflected upon the rarity of the same while its high percentage has previously been reported in contemporary Hungarian population frequency being 2.5% (Mavrodisz et al., 2007).

High frequency of shovel incisors and low frequency of carabelli's trait has been regarded as strong ethnic indicator for the mongoloid populations (Dahlberg, 1951) inverse of which has been observed in the present study. Only few cases of shovel trait have been found in Jat Sikh population (combined frequency being 3.4%). Again this finding is consistent with the fact the Mongoloid populations differ from Caucasoid by having a high prevalence of shovel trait and a low prevalence of Carabelli's trait (Tsai et al., 1998).

On the whole, significant differences in frequency of occurrence of dental anomalies were found between two populations of the present study and previous studies on other Indian populations. Primary factors for these contrasting results may be summarized as sampling techniques, genetic factors, effect of local environment and nutrition.

Frequency of anomalies can also provide exclusionary evidence as in present study, high percentage of Carabelli's trait has been observed in both the population groups as compared to other populations. Although entitled only as biologic variations, some of these dental characteristics form important basis of racial identification i.e. differentiation can be made between mongoloids, negroids and caucasoids.

References

1. Altug-Atac, A.T., Erdem, D., 2007. Prevalence and distribution of dental anomalies in orthodontic patients. Am J Orthod Dentofacial Orthop. 131, 510-514.
2. Alvesalo, N., Nuutila, M., Portin, P., 1975. The cusps of Carabelli, occurrence in first upper molars and evaluation of its heritability. Acta Odontol Scand. 33, 191–197.
3. Bot, P.L., Salmon, D., 1977. Congenital defects of the upper lateral incisors (ULI): condition and measurements of the other teeth, measurements of the superior arch, head and face. Am J Phys Anthropol. 46, 231-244.
4. Dahlberg, A.A., 1950. The evolutionary significance of the protostylid. Am J Phys Anthropol. 8, 15-25.
5. Dahlberg, A.A., 1951. The dentition of the American Indian. In: Laughlin, W.S. (Ed.) The physical anthropology of the American Indian. Viking Fund, New York.
6. Davis, P.J., 1987. Hypodontia and hyperdontia of permanent teeth in Hong Kong schoolchildren. Community Dent Oral Epidemiol. 15, 218-20.
7. Ezoddini, A.F., Sheikhha, M.H., Ahmadi, H., 2007. Prevalence of dental developmental anomalies: a radiographic study. Community Dent Health. 24, 140-144.
8. Ferraz, J.A., deCarvalho, J.R., Saquy, P.C. , Pécora, J.D., Sousa-Neto, M.D., 2001. Dental anomaly: dens evaginatus (Talon cusp). Brazilian Dental Journal. 12, 132-134.
9. Garant, P.R., 2003. Early Tooth development. In: Garant, P.R. (Ed.) Oral cells and tissues. Quintessence, Chicago, pp.1-23.
10. Garvey, M.T., Barry, H.J., Blake, M., 1999. Supernumerary teeth- An overview of classification, diagnosis and management. J Can Dent Assoc. 65, 612-616.
11. Gaspersic, D., 1997. Identification of protostylid. Anthropol Anz. 55, 43-53.

12. Goose, D.H., Lee, G.T.R., 1971. The mode of inheritance of Carabelli's trait. Hum Biol. 43, 69 – 91.
13. Goya, H.A., Tanaka, S., Maeda, T., Akimoto, Y., 2008. An orthopantomographic study of hypodontia in permanent teeth of Japanese pediatric patients. J Oral Sci. 50, 143-50.
14. Grine, F.E., 1986. Anthropological aspects of the deciduous teeth of South African blacks. In: Singer, R., Lundy, J.K., (Eds.) Variation, Culture and Evolution in African Populations. Witwatersrand University Press, Johannesburg, pp. 47-83.
15. Grover, P.S., Carpenter, W.M., Allen, G.W., 1982 Panographic survey of US army recruits: analysis of dental health status. Mil Med. 147, 1059-61.
16. Gupta, B.R., 1975. The Aggarwals: A socioeconomic study. S. Chand & Co, New Delhi.
17. Hanihara, K., 1963. Crown characters of the deciduous dentition of the Japanese-American hybrids. In: Brothwell, D.R. (Ed.) Dental anthropology. Pergamon Press, London, pp.105-124.
18. Hanihara, T., 2008. Morphological variation of major human populations based on nonmetric dental traits. Am J Phys Anthropol. 136, 169-182.
19. Hattab, F.N., Yassin ,O.M., al-Nimri, K.S., 1996. Talon cusp in permanent dentition associated with other dental anomalies: review of literature and reports of seven cases. ASDC J Dent Child. 63, 368-376.
20. Hsu, J.W., Tsai, P., Liu, K., Ferguson, D., 1997. Logistic analysis of shovel and carabelli's tooth traits in a Caucasoid population. Forensic Sci Int. 89, 65-74.
21. Hsu, J.W., Tsai, P.L., Hsiao, T.H., Chang, H.P., Lin, L.M., Liu, K.M. Yu, H.S., Ferguson, D., 1999. Ethnic dental analysis of shovel and Carabelli's traits in a Chinese population. Aust Dent J. 44, 40-45.
22. Keen, H.J., 1963. Distribution of diastemas in the dentition of man. Am J Phys Anthropol. 21, 437-441.
23. Konjhodžic-Rašcic, H., Vukovic, A., Zukic, S., Bajsman, A., Prcic, A., 2006. Dental anomalies among students of Faculty of Dentistry, University of Sarajevo. Acta Medica Academica. 35, 23-29.
24. Krapp, K., Cengage, G., eds., 2002. Dental Anomalies. Available at: http://www.enotes.com/nursing-encyclopedia/dental-anomalies. Accessed March 17, 2010
25. Mavrodisz, K., Rózsa, N., Budai, M., Soos, A., Pap, I., Tárjan, I., 2007. Prevalence of accessory tooth cusps in a contemporary and ancestral Hungarian population. Eur J Orthod. 29, 166-169.
26. Mizoguchi, Y., 1985. Shovelling: A statistical analysis of its morphology. Bulletin no. 26, University Museum, University of Tokyo.
27. Nainar, S.M., Gnanasundaram, N., 1989. Incidence and etiology of midline diastema in a population in south India (Madras). Angle Orthod. 59, 277-282.
28. Neves, A.A., Neves, M.L., Farinhas, J.A., 2002.Bilateral connation of permanent mandibular incisors: A case report. Intl J Paediatr Dent. 12, 61-65.
29. Palomino, H., Chakraborty, R., Rothhammer, F., 1977. Dental morphology and population diversity. Hum Biol. 49, 61–70.
30. Peck L, Peck S, Attia Y. Maxillary canine-first premolar transposition, associated dental anomalies and genetic basis. Angle Orthod. 1993; 63: 99–109.
31. Peck, S., Peck, L., 1995. Classification of maxillary tooth transpositions. Am J Orthod Dentofacial Orthop. 107, 505–517.
32. Petju, M., Suteerayongprasert, A., Thongpud, R., Hassiri, K., 2007. Importance of dental records for victim identification following the Indian Ocean tsunami disaster in Thailand. Public Health 121,251-257.
33. Pinho, T., Tavares, P., Maciel, P., Pollmann, C., 2005. Developmental absence of maxillary lateral incisors in the Portuguese population. Eur J Orthod. 27, 443-449.

34. Pretty, I.A., Addy, L.D., 2002. Associated postmortem dental findings as an aid to personal identification. Sci Justice 42, 65-74.
35. Pretty, I.A., Sweet, D., 2001. A look at forensic dentistry- Part I: The role of teeth in the determination of human identity. Brit Dent J. 190, 359-66.
36. Reddy, V.R., 1983. Carabelli's anomaly in a Karnataka town of south India. Acta Anthropogenet. 7, 53-74.
37. Reddy, V.R., ed., 1985. Dental Anthropology: Application and methods. Inter-India Publications, New Delhi, pp.161-164.
38. Rusmah, M., 1992. The cusp of Carabelli in Malaysians. Odontostomatol Trop. 15, 13-15.
39. Salako, N.O., Bello, L.L., 1998. Prevalence of the Carabelli trait in Saudi Arabian children. Odontostomatol Trop. 21, 11-14.
40. Sema Aka, P., Canturk, N., Dagalp, R., Yagan, M., 2009. Age determination from central incisors of fetuses and infants. Forensic Sci Int. 184, 15–20.
41. Shafer, W.G., Hine, M.K., Levy, B.M., 2001. A Textbook of Oral Pathology. W.B. Saunders & Company, Philadelphia, PA.
42. Sharawy, M., Bhussry, B.R., 1990. Development and growth of teeth. In: Bhaskar, S.N., (Ed.) Orban's Oral Histology and Embryology. CBS Publishers and Distributors, Delhi, pp. 40-44.
43. Slootweg, P.J., 2007. Dental pathology: a practical introduction. Springer, New York, pp. 11
44. Steigman, S., Wiessberg, Y., 1985. Spaced Dentition: An epidemiologic study. Angle Orthod. 55, 167-176.
45. Stevenson, R.E., Hall, J.G., 2006. Human malformations and related anomalies. Oxford university press, United Kingdom.
46. Thesleff, I., 2006. Genetic basis of tooth development and dental defects. Am J Med Gen A 140, 2530-2335.
47. Tsai, P.L., Hsu, J.W., Lin, L.M., Liu, K.M., 1998. Logistic analysis of the effects of shovel trait on Carabelli's trait in a Mongoloid population. Am J Phys Anthropol. 100, 523-530.
48. Turner, C.G. II, Nichol, C.R., Scott, G.R., 1991. Scoring procedures for key morphological traits of the permanent dentition: the Arizona State University Dental Anthropology System. In: Kelley, M.A., Larsen, C.S., (Eds.) Advances in dental anthropology. Wiley-Liss, New York, pp. 13-31.
49. Yilmaz, H.H., Türkkahraman, H., Sayin, M.Ö., 2005. Prevalence of tooth transpositions and associated dental anomalies in a Turkish population. Dentomaxillofac Rad. 34, 32-35.
50. Yonezu, T., Hayashi, Y., Sasaki, J., Machida, Y., 1997. Prevalence of congenital dental anomalies of the deciduous dentition in Japanese children. Bull Tokyo Dent Coll. 38, 27-32.