

# Prevalence of aberrant dental morphological details in 6-10 year old school children in an Indian population

M. KIRTHIGA, M. MANJU, R. PRAVEEN<sup>1</sup>, W. UMESH<sup>2</sup>

## Abstract

**Background:** Variations in the structure of teeth have always been a great curiosity to the dentist from the scientific and practical point of view. **Aim:** To evaluate the prevalence of a few aberrant morphological features namely, cusp of Carabelli in primary maxillary second molar and in permanent first molar, five cusp in primary maxillary second molar and permanent first molar, shoveling and double shoveling with respect to permanent maxillary central incisors, four cusped primary mandibular second molar and permanent first molar, six cusped primary mandibular second molar and permanent first molar and seven cusped primary mandibular second molar and permanent first molar in 6–10 year old children belonging to the East Bengaluru, a City in India. **Design:** A cross-sectional survey was conducted among 2111 children by two stage sampling method. Type III examination was performed. The findings were subjected to Chi-square test. **Results:** 83.8% of the studied population had one or more of the variations checked for, as mentioned above. The variation most commonly seen was double shoveling (66.6%) followed by shoveling (65.7%). No significant results were observed in any trait with respect to gender. **Conclusion:** This study is the first of its kind, providing a baseline data of the prevalence of morphological details in the pediatric Indian population.

**Keywords:** Morphological variations, prevalence, school children

## Introduction

Dental morphological details are valuable for understanding variations among species and adds information for phylogenetic and genetic studies. It is useful for collating and distinguishing population as there is varying degrees of expression of dental features. Analysis of racial differences in dental morphology has led to the opinion that the common origins of people are reflected to a certain degree in their similar phenotypic patterns.<sup>[1]</sup>

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The maxillary molar consists of four major cusps: Protocone (mesiopalatal), paracone (mesiobuccal), metacone (distobuccal), and hypocone (distopalatal).

Cusp 5 or metaconule in permanent maxillary first molar is an accessory cusp found on the distal marginal ridges between the distobuccal (metacone) and the distolingual (hypocone) cusp.<sup>[2]</sup>

Lingual and labial marginal ridging called as shoveling and double shoveling respectively are other traits included in the study. It is well known that labial ridges are said to be always less prominent than lingual ridges.<sup>[2]</sup>

The cusp of Carabelli [Figure 1] is a distinctive morphological variant located on the mesiopalatal surface of the upper first permanent molars and upper second primary molars. It was first described in 1842 by Carabelli. It is most commonly been detected symmetrically on both sides of the upper jaw (Alvesalo *et al.*, 1975). As the incidence and degree of expression differs among species; it can be used to detect and compare different populations. The degree and expression of cusp of Carabelli can range from small ridge, pit, furrow or as a tubercle.<sup>[3-9]</sup>

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The lower molars have five major cusps: Protoconid (mesiobuccal), metaconid (mesiolingual), hypoconid (distobuccal), entocid (distolingual), and hypoconulid (distal).

The sixth cusp [Figure 2a] is also called as the tuberculum accessorium posterior internum or tuberculum septum. This accessory cusp is said to be seen between the distal and distolingual cusps of the primary and permanent mandibular molars, more common with the permanent ones.<sup>[10]</sup>

Four cusp pattern in mandibular first molar is another deviant feature often seen where the distal cusp is absent [Figure 2b]. The seventh cusp [Figure 2c] was also identified in the mandibular first permanent molar. It is present between the mesiolingual and the distolingual cusp, and is termed as the tuberculum intermedium.<sup>[2,10]</sup>

Literature search revealed that no studies have been performed regarding the prevalence of the known morphological details in a large population. Present research in this area provides information regarding prevalence or case report of any one particular trait. Hence, the present study was undertaken to evaluate the prevalence of aberrant dental morphological details in mixed dentition among Indian pediatric population aged 6–10 years. The following features were assessed in the maxilla - cusp of Carabelli in primary second molar and permanent first molar, five cusp primary second molar, five cusp permanent first molar, shoveling, and double shoveling with respect to permanent central incisors. In the mandible the variants evaluated were four cusped primary second molar, four cusped permanent first molar, six cusped primary second molar, six cusped permanent first molar, seven cusped primary second molar, and seven cusped permanent first molar.

## Materials and Methods

This descriptive cross-sectional survey was carried out on



**Figure 1:** Grade 7 of cusp of Carabelli (according to Dahlberg's classification)

school-going children aged 6–10 years from East Bengaluru, a City in India.

## Ethical approval

The proposed research protocol was reviewed by Institutional Review Board and ethical approval was obtained. Participant information form was sent to all parents/guardians of the selected children explaining the purpose, procedure, and significance of the study in the local language. Only those children were included whose parents or guardians signed the consent form.

## Selection criteria

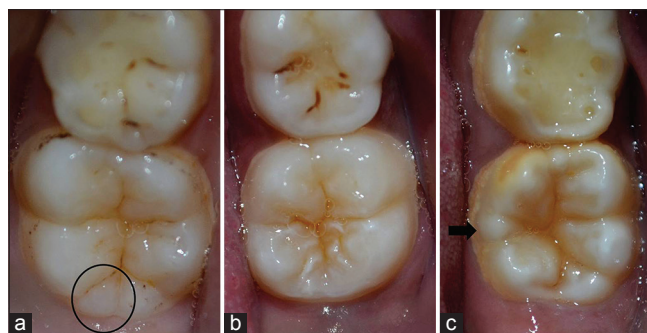
The subjects with orthodontic treatment, traumatic injuries to teeth, with special health care needs, teeth with extensive caries/restorations/developmental anomalies, attrited cusps and having non-eruption/partial eruption of the desired tooth unilaterally/bilaterally were not included in the study.

## Sampling methodology

Two-stage random sampling was done using school as the primary sampling entity and individual child as the entity of enquiry. In the first stage, 10 schools were randomly chosen from the list of schools located in the east zone municipal area of Bengaluru city. Subjects from each school were chosen using proportionate stratified random sampling in the second stage.

## Clinical examination

Type III clinical examination was conducted in a suitable classroom using a mouth mirror and probe under natural light. Cotton rolls were used to clean the teeth off food debris and to dry them. A special performa was designed to collect the required data. The following features were assessed in the maxillary - cusp of Carabelli in primary second molar and in permanent first molar, five cusp primary second molar, five cusp permanent first molar, shoveling and double shoveling with respect to permanent central incisors. In the mandible the variants evaluated were four cusped primary second molar, four cusped permanent first molar, six cusped primary second molar, six cusped permanent first molar, seven cusped primary second molar,



**Figure 2:** (a-c) Cusp 6, cusp 4, and cusp 7 respectively in a permanent mandibular molar

and seven cusped permanent first molar. The degree of expression of cusp of Carabelli was also observed as given by Dahlberg in 1963 [Table 1].<sup>[4]</sup> In Dahlberg's classification, four grades (1–4) are interpreted as negative and three grades (5–7) as positive trait forms.

### Sample size calculation

The sample size is determined using data of the prevalence of cusp of Carabelli on permanent first molars from an Indian study.<sup>[5]</sup> Type one error was fixed at 5% and allowable error at 5% of prevalence. Prevalence of cusp of Carabelli on permanent first molars was 63.7%. A sample size of 755 school children was calculated. In the present study, in addition to the cusp of Carabelli several other variables were also considered. Hence, to increase the power of the study the sample size was increased up to 2111.

### Statistical analysis

Descriptive summary statistics were obtained for all independent variables. The Chi-square test was applied to see the variation of different developmental anomalies across genders. All significant differences were detected at 95% of confidence level. Statistical analyses were carried out using SPSS (Statistical Package for the Social Sciences) Version 17.

**Table 1: Classification of cusp of Carabelli according to Dahlberg (1963)**

Degree	Expression
0	Smooth mesiobuccal crown surface
1	Small vertical ridge and groove
2	Small pit with minor grooves diverging from depression
3	Double vertical ridges or slight and incomplete cusp outline
4	Y form
5	Small tubercle
6	Broad cusp outline with a moderate tubercle
7	Large tubercle with a free apex

**Table 2: Prevalence of deviant morphological features and their unilateral/bilateral occurrence in children aged 6-10 years from East Bengaluru, India**

Feature	Present	Percentage	Unilateral	Percentage	Bilateral	Percentage
Shoveling	1387	65.7	15	1	1372	99
Double shoveling	1407	66.6	13	0.9	1394	99.1
Cusp of Carabelli (16/26)	839	39.7	4	0.4	835	99.6
Cusp of Carabelli (55/65)	852	40.3	1	0.1	851	99.9
5 cusp maxillary first molar (16/26)	373	17.8	1	0.2	372	99.8
5 cusp maxillary first molar (55/65)	4	0.2	1	0.2	3	99.8
6 cusp mandibular first molar (36/46)	129	6.1	24	18.6	105	81.4
6 cusp mandibular first molar (75/85)	52	2.5	3	5.7	49	94.3
7 cusp mandibular first molar (36/46)	104	4.9	1	0.9	103	99.1
7 cusp mandibular first molar (75/85)	4	0.2	0	0	4	100
4 cusp mandibular first molar (36/46)	376	17.8	1	0.2	375	99.8
4 cusp mandibular first molar (75/85)	0	0	0		0	

## Results

Of 2111 children examined, only 363 children did not demonstrate any variation from the customary shape. Table 2 shows the prevalence of deviant morphological features and their unilateral/bilateral occurrence. The prevalence of the variants was also categorized according to the gender preference as shown in Table 3. No significant difference was observed with respect to the same. Table 4 shows the degree of expression of Carabelli trait according to Dahlberg's classification (1963) in the maxillary permanent first molar and primary second molar.

## Discussion

The world renowned paleontologist William King Gregory (1922) opined that tooth crown morphology varied scarcely among the major races of mankind. Exceptions to this overview are the cusp of Carabelli and the molar cusp pattern and number.<sup>[10]</sup>

However in the recent past, variations have also been noted in the anterior teeth which include shoveling and double shoveling.

Hence, this pioneering investigation facilitated the observation of unknown aberrant features in the mixed dentition which has been an unexplored research area until date. This cross-sectional study was conducted among school going children aged 6–10 years in Bengaluru City, Karnataka. The age group chosen was based on the eruption schedule of primary and permanent teeth providing a standard to monitor the variations in morphological features in mixed dentition. The feature most commonly seen in the elected Indian pediatric population was double shoveling (66.6%), which was followed by shoveling (65.7%) [Figure 3a and b]. This observation is slightly more when

**Table 3: Prevalence of deviant morphological features according to gender in children aged 6-10 years from East Bengaluru, India**

Feature	Males	Females	P
Shoveling	705	682	0.213
Double shoveling	713	694	0.244
Cusp of Carabelli (16/26)	427	412	0.89
Cusp of Carabelli (55/65)	430	422	0.665
5 cusp maxillary first molar (16/26)	176	197	0.601
5 cusp maxillary first molar (55/65)	2	2	0.999
6 cusp mandibular first molar (36/46)	71	58	0.649
6 cusp mandibular first molar (75/85)	19	33	0.144
7 cusp mandibular first molar (36/46)	56	48	0.815
7 cusp mandibular first molar (75/85)	2	2	0.999
4 cusp mandibular first molar (36/46)	177	199	0.569
4 cusp mandibular first molar (75/85)	0	0	0

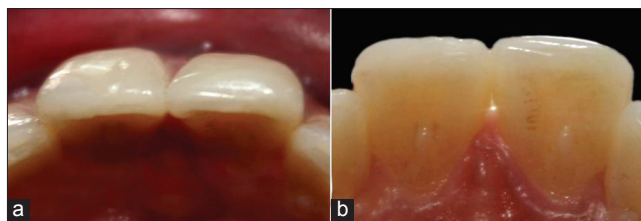
**Table 4: Degree of expression of cusp of Carabelli in permanent and primary molar**

Degree of cusp of Carabelli	Frequency in 16/26	Percentage	Frequency in 55/65	Percentage
0	1272	60.2	1259	59.6
1	294	13.9	294	13.9
2	193	9.1	191	9
3	109	5.1	99	4.6
4	95	4.5	95	4.5
5	78	3.6	88	4.1
6	42	1.9	47	2.2
7	28	1.3	38	1.8

compared with another study conducted by Khraisat *et al.* in Jordanian population (53%).<sup>[10]</sup>

The next trait in the order of prevalence was the cusp of Carabelli in primary second molar (40.3%), and subsequently the cusp of Carabelli in permanent first molar (39.7%). Literature is replete with studies<sup>[5-9]</sup> showing the prevalence of cusp of Carabelli in permanent and primary teeth ranging from 2.1–85.7% to 67.5–89.8%, respectively. The present study showed a prevalence percent in permanent teeth that fit well within the range, but in primary teeth it was comparatively lesser. The reason for the same could be because of a few prevalence studies with respect to primary teeth that have been carried out.

This trait was also observed in the permanent second molar in a few studies<sup>[5,7,10]</sup> However, this was not feasible in the present study due to age constraints. When the degree of expression of cusp of Carabelli in permanent maxillary first molar was taken into consideration, absence of trait was seen in 60.2%, a negative expression in 32.6%, and a positive expression in 6.8%. Comparable to this observation, in the



**Figure 3:** (a and b) Double shoveling and shoveling in maxillary central incisors respectively

primary maxillary second molar, the absence of trait in 59.6%, a negative expression of 32.0%, and a positive expression of 8.1% were noted. This result is in dissimilarity to a present study by Kamatham and Nuvvula where a positive expression was seen in 27.6% of primary second molars, 30.7% of permanent first molars, negative expression was noticed in 62.2% of primary second molars, 33.1% permanent first molars, and the nonexistence of the trait in 10.2% of primary second molars, 36.2% permanent first molars.<sup>[6]</sup> The probable explanation for this disparity between study results could be due to the variation in the origin of the studied population.

About 17.8% of mandibular first molar showed four cusped patterns in permanent teeth. The finding is comparable to a previous study carried out in Indian population revealing a prevalence rate of 18%.<sup>[11]</sup> Another study was conducted by Turner, where Indians, Aleuts, and Eskimos (1%) were compared. Results showed the absence of four cusped permanent first molar<sup>[12]</sup> four cusped pattern. When primary teeth were examined, this feature was totally nonexistent. The literature search did not reveal any information regarding the occurrence of this feature in primary teeth as well.

A feature unnoticed till date is the five cusped maxillary first molar. In the present study, a prevalence rate of 17.8% was found with respect to permanent teeth. Nevertheless, very few children were noticed with this feature in primary teeth (0.2%).<sup>[4]</sup>

Another interesting trait recorded in the mixed dentition is the six cusped mandibular first molar. The prevalence percentage was 6.1 and 2.5 in permanent and primary teeth respectively. The prevalence was quite less when compared to the study by Turner. The outcome showed a prevalence rate of 65% with Indians, 21% with Aleuts, and 22% with Eskimos when the permanent teeth were considered.<sup>[12]</sup>

The last deviant feature checked for is the seven cusped mandibular first molar which showed a prevalence of 4.9% with permanent teeth and 0.2% when primary teeth were taken into account. The results of the present study are comparatively less to a study done in the Indian population where a prevalence of 11.2% was observed.<sup>[13]</sup>

Dental anomalies are caused by complex multifactorial interactions between genetic, epigenetic, and environmental

factors during the long process of dental development.<sup>[14]</sup> Tooth type is determined by epithelial signals which involve differential activation of homeobox genes in the mesenchyme. This differential signaling could have been the possible reason for variation in the tooth type.<sup>[14-16]</sup>

Various fibroblast growth factors such as 4, 8, and 9 have been regarded as epithelial signals regulating mesenchymal gene expression and cell proliferation in concern with epithelial morphogenesis.<sup>[16]</sup>

Sex determination can be done using dental features such as C trait, shoveling of incisor which is a nonmetric trait. No significant difference was observed in the aforementioned variations between boys and girls. When cusp of Carabelli is taken into consideration, the present study is in accordance with a few other studies.<sup>[3,6,17,18]</sup> Even though no significant difference was seen, males were slightly more affected than females as also noticed in a previous study.<sup>[6]</sup> Evolution has resulted in crown diminution in females, could be the most likely reason for the same. The current study is in agreement with a Japanese study which showed no significant difference in the cusp numbers of the permanent first molar between males and females.<sup>[19]</sup>

When trait symmetry was considered, most of the children showed the bilateral presence of the variants. This finding coincides with one more study when the trait symmetry of cusp of Carabelli was considered.<sup>[6]</sup>

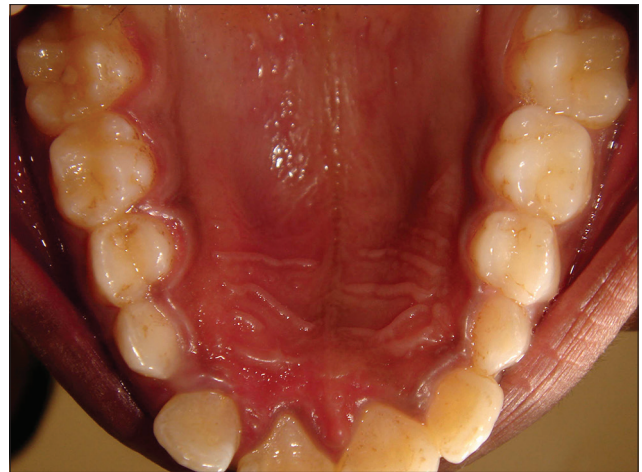
One striking feature noted was most of the children showed the simultaneous occurrence of a particular trait, both in primary and permanent dentitions bilaterally [Figure 4].

#### Forensic significance

- The morphological variation could be a useful tool to identify and categorize populations to which an individual belongs. For instance, the sixth cusp has been described as a racial characteristic trait of the mongoloids and Caucasians are proved to have a high prevalence rate of cusp of Carabelli
- A thorough knowledge of these traits is required for a pediatric dentist for clinical applications that includes identification of deep fissures/incipient caries, application of pit and fissure sealants, extending to the fissures during cavity preparation, etc
- Antemortem dental profile of every patient should be recorded and maintained. This could be of forensic value for the identification of an individual.

#### Conclusion

About 82.7% of the studied pediatric population had one or more deviant morphological features of primary and permanent teeth. The most common feature present was



**Figure 4:** The simultaneous occurrence of cusp of Carabelli in primary and permanent dentitions bilaterally

double shoveling followed by shoveling and the cusp of Carabelli.

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#### Conflicts of interest

There are no conflicts of interest.

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