

# Prevalence of cusp of Carabelli among medical and dental students of a medical college of Nepal: A descriptive cross-sectional study

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## ABSTRACT

**Introduction:** Carabelli's trait has been used as an ethnic indicator for decades because of its ease of observation in living and skeleton specimens. It has importance in forensic, anthropological, and ethnic studies.

**Objectives:** The present study aimed to determine the prevalence and degree of expression of the cusp of Carabelli in the maxillary first molar among medical and dental students.

**Methodology:** This cross-sectional descriptive study was conducted from February 2024 to August 2024 among 221 medical and dental students using convenience sampling after obtaining institutional ethical approval. The palatal surfaces of mesiolingual cusp of permanent maxillary first molars were examined using a sterile mouth mirror and probe. The Carabelli trait was graded according to the classification given by Goose and Lee. The SPSS v.26 was used for statistical analysis. Descriptive statistics were presented as percent and frequency for categorical data.

**Results:** The Cusp of Carabelli was prevalent in 160 (72.40%). The Grade II pattern was the highest (136, 30.77%), and the Grade IV pattern was the lowest (32, 7.24%). Among males, 104 (73.24%) and among females 56 (70.89%) had the Carabelli trait present. The bilateral cusp of Carabelli was observed in 117 (73.13%) participants. Brahmins had the highest (77, 78.57%) and Muslims had the lowest (3, 42.86%) prevalence of cusp of Carabelli.

**Conclusion:** The prevalence of cusp of Carabelli in Maxillary first molar in Nepali Medical and dental students was higher compared to other populations. However full expression of a well-developed cusp was quite low in the present study.

**Keywords:** Cusp of Carabelli; Nepal; Prevalence.

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## INTRODUCTION

The Carabelli structure is a tubercle or cusp, or groove, often seen on the palatal surface of the mesiolingual cusp of maxillary permanent molars and maxillary second deciduous molars.<sup>1</sup> It includes expressions ranging from complete absence to pits, grooves, tubercles, cusplet, or cusps and is believed to be caused by the interplay of genetic and environmental factors.<sup>2</sup>

The Carabelli trait is one of the most studied non-metric traits and is important in forensic, anthropological, and ethnic studies.<sup>3,4</sup> Carabelli's trait has been used as an ethnic indicator for decades because of its ease of observation in living and skeleton specimens. This can reveal significant ethnic differences in dentition.<sup>3,5</sup>

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Few studies have been conducted on Carabelli traits in the Nepali population so far. The present study aimed to determine the prevalence and degree of expression of the cusp of Carabelli in the maxillary first molar among medical and dental students.

## METHODOLOGY

This cross-sectional descriptive study was undertaken among medical and dental students at the Institute of Medicine in Kathmandu, Nepal from 2024 February to August 2024. We obtained ethical approval from the Institutional Review Committee of the Institute of Medicine (Reference number: 338(6-11)E2,080/081), ensuring that all necessary ethical standards were met. All the participants were informed about the study and written consent was taken. The palatal surfaces of the mesiolingual cusp of the left and right first molars of the subjects were examined with a sterile mouth mirror and a probe for the presence or absence of the Carabelli trait.

When present, the Carabelli trait was graded as I-IV, pit (I), groove (II), cusp without free tip (III), and well-developed cusp (IV) according to the classification of Goose and Lee.<sup>4</sup>

The trait was considered not present when the palatal surface of the maxillary first permanent molar's mesiolingual cusp was convex and smooth. Pits were identified when a catch was felt while moving the probe tip over a specific tooth surface. A groove was identified when a vertical running gutter was felt from the cervical margin to the cusp summit. For Carabelli cusps without a free tip, the tip is fused with the mesiolingual cusp of the tooth, leaving only the prominence of the tubercle visible. Two curved grooves separated this prominence from the tooth's surface. A well-developed cusp could be observed intraorally as it projected like an additional cusp.

Participants with fully erupted permanent first molars were included in the study. The participants having a history of cross ethnicity, fully restored carious or missing maxillary first molars were excluded from the study. The Convenience sampling method was used, and the sample size was calculated using the Prevalence of the Carabelli Trait in Selected Nepali Population by Subedi et al.<sup>4</sup> using the formula,

$$n = Z^2 pq / e^2;$$

$$= (1.96)^2 \times 0.68 \times (1-0.68) / (0.05)^2$$

$$= 333; \text{ Where, } n = \text{minimum required sample size for an infinite population; } Z= 1.96 \text{ at } 95\% \text{ Confidence Interval (CI); } p = 68.3\%, \text{ prevalence of Cusp of Carabelli in Selected Nepali Population;}^4 q = 1-p; e= \text{margin of error, } 5\%. \text{ The calculated minimum sample size for an infinite population is } 333. \text{ We have } 650 \text{ total MBBS and BDS students studying at Institute of Medicine. Sample size for finite population} = n / [1 + \{(n-1)/\text{Population}\}]$$

The sample size calculated was 221. Participants were categorized into different ethnic groups according to demographic and health survey 2022.<sup>6</sup> The data was entered in Microsoft Excel. IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA) was used for statistical analysis. Descriptive statistics were presented as proportions (Percents) and frequency for categorical data.

## RESULTS

Among the 221 dental and medical students, 142 (64.25%) were males and 79 (35.75%) were females. The mean age of the participants was  $22.27 \pm 2.08$  years. Among the total participants, 160 (72.40%) had the Carabelli trait on either of their first molars (16 or 26).

Among 442 maxillary first molars examined, 277 (62.67%) had Carabelli traits present and 165 (37.33%) did not have Carabelli traits. The distribution of different expressions of the Carabelli trait among dental and medical students is shown in Table 1 which shows the Grade II pattern was highest 136 (30.80%) and the Grade IV pattern was lowest 32 (7.20%).

Among the participants who had a cusp of Carabelli present, 117 (73.13%) revealed bilateralism of the cusp of Carabelli, and 43 (26.87%) had a unilateral presentation (Figure 2).

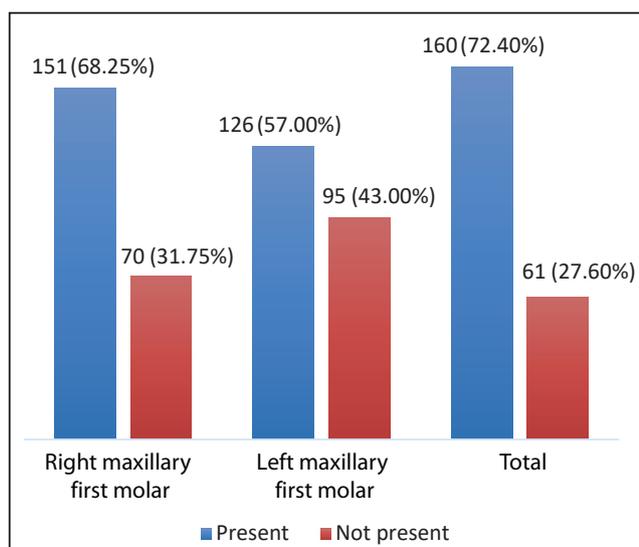
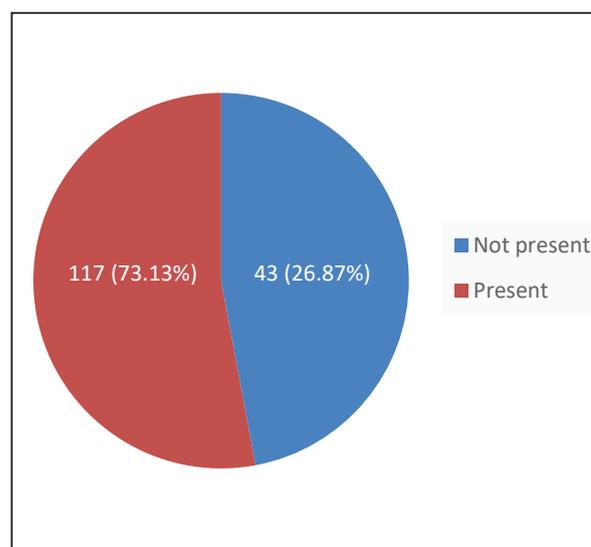
The distribution of the cusp of Carabelli traits according to sex and ethnicity which reveals 104 (73.24%) of males and 56 (70.89%) of females had Carabelli traits present (Table 2). Brahmins had the highest 77 (78.57%) and Muslims had the lowest three (42.86%) prevalence of cusp of Carabelli.

**Table 1: Distribution of cusp of Carabelli among medical and dental students (n=221)**

Cusp of Carabelli	Right maxillary first molar n (%)	Left maxillary first molar n (%)	Total no of teeth n (%)
<b>Present</b>	<b>151 (68.33)</b>	<b>126 (57.01)</b>	<b>277 (62.67)</b>
Grade I	26 (11.76)	27 (12.22)	53 (11.99)
Grade II	78 (35.30)	58 (26.24)	136 (30.77)
Grade III	32 (14.48)	24 (10.86)	56 (12.67)
Grade IV	15 (6.79)	17 (7.69)	32 (7.24)
<b>Not present</b>	<b>70 (31.67)</b>	<b>95 (42.99)</b>	<b>165 (37.33)</b>

**Table 2: Presence/absence of cusp of Carabelli according to sex and ethnicity(n=221).**

Variables	Cusp of Carabelli n (%)	
	Present	Not present
<b>Sex</b>		
Male	104 (73.24)	38 (26.76)
Female	56 (70.89)	23 (29.11)
<b>Ethnicity</b>		
Brahmin	77 (78.57)	21 (21.43)
Chhetri	12 (57.14)	9 (42.86)
Dalit	3 (75.00)	1 (25.00)
Janajati	18 (64.29)	10 (35.71)
Madhesi	47 (74.60)	16 (25.40)
Muslim	3 (42.86)	4 (57.14)

**Figure 1: Presence of cusp of Carabelli among study participants (n=221)****Figure 2: Bilateral presence of cusp of Carabelli (n=160)**

## DISCUSSION

The Carabelli trait is one of the most studied non-metric traits, first described by Sir George Carabelli in 1842. It can be useful in establishing phylogenetic relationships between closely related populations.<sup>7-9</sup>

The expression of the cusp of Carabelli is variable in different populations and in people of different ethnic origins. The general trend is for this trait to be more

common in Southern Chinese than in other Mongoloid groups.<sup>9</sup> The Carabelli cusp is considered a significant dental indicator of Chinese and Caucasoid ancestry.<sup>8</sup> The distribution of races within a population, the homogeneity of European and oriental populations, and the classification of a population into western or oriental type dentition can all be determined by the form and presence of Carabelli cusps.<sup>7</sup>

In the present study, out of 221 participants, the prevalence of the cusp of Carabelli was 160 (72.40%). Tooth 16 showed presence in 151 (68.33%), while 26 showed presence in 126 (57.01%). Subedi et al conducted a study among 300 patients and found the Prevalence of cusp of Carabelli 205 (68.3%) in the Chitwan district of Nepal. In their study, tooth 16 showed the presence in 190 (63.3%), and 26 showed the presence in 166 (55.3%) out of 300 participants studied. These findings are similar to the present study.<sup>4</sup> In a study conducted in Bengaluru, India, the prevalence of the cusp of Carabelli was found to be 87.6% which is slightly higher than the present study.<sup>3</sup> In another study conducted among 254 South Indian children, expression of the cusp of Carabelli in primary and permanent molars was observed. In contrast, they revealed the positive expression of the Carabelli trait only on 30.7% of permanent maxillary first molars, which is quite less than other studies.<sup>10</sup> The prevalence of Carabelli cusps in permanent maxillary first molars was only 57.6% in the Saudi population, which is less than seen in our study.<sup>1</sup> The prevalence of the cusp of Carabelli in the Nigerian population was 17.43% and 31-35% in the Kenyan African population, which is lower compared to our study.<sup>11,12</sup> The prevalence of cusp of Carabelli was 65.34 % in Hungarian Populations and 63% in North American whites.<sup>7,13</sup> Systematic review and meta-analysis of different studies of Carabelli's cusp around the world shows a prevalence rate of 59% for the maxillary first molar.<sup>14</sup> It is most frequent among Europeans, with the most pronounced variants occurring in Asians.<sup>8,9</sup> In the Nepali population, however the prevalence appears to be on the higher side.

The bilateral presence of the Carabelli trait in 16/26 was noticed in 151 (73.7%) of the total 205 cases in the study done by Subedi et al in the selected Nepali population which is in accordance with the present study where bilateral presentation was seen in 117 (73.13%).<sup>4</sup> In another study done on the Cusp of Carabelli trait in the western hilly region of Nepal bilateral presentation was observed in 62.12% of cases which is also similar to the present findings.<sup>5</sup> Bilateral cusp of Carabelli was seen in 90% of cases in the study conducted in Bengaluru, India which is higher than the present study.<sup>3</sup> In another study on the Saudi population, the first molar bilateralism was observed in 91.2%.<sup>1</sup> In contrast, the bilateral cusp of Carabelli in the permanent maxillary first molar was noted in only 54.3% of the South Indian children in the study conducted by Kamatham and Nuvvula.<sup>10</sup> These data suggest there is not only variation on the prevalence of the Carabelli trait but also variation in the bilateral presentation in different populations.

In the present study, Goose and Lee's classification was used to interpret the expression of the cusp of Carabelli, where the expression of the Grade II pattern was highest, 136 (30.77%) and the Grade IV pattern was lowest 32 (7.24%). In the study done by Subedi et al Grade I pattern was the most prevalent pattern, followed by the Grade II pattern in the maxillary first molars. Similar to the present study, the Grade IV pattern was the least expressed pattern in their study.<sup>4</sup> Although the frequency of Carabelli's cusp is in the Nepali population, well developed cusp is less commonly noted in the Nepali population.

There was little difference in the presence of the cusp of Carabelli between males and females in our study. These findings are supported by the different studies, which show no significant association between the cusp of Carabelli trait and sex.<sup>4,5,9,10,13</sup> In contrast to these findings, studies in the Japanese and Chinese populations show higher rates in males compared to females.<sup>15</sup> In another study in Jordanian population study has revealed significant sexual dimorphism.<sup>16</sup>

Nepal is a country with a diversified population and ethnic composition.<sup>17</sup> There are few studies conducted in the Nepali population so far to find the association of the cusp of Carabelli with ethnic variation. In a study conducted by Sah et al., Carabelli's cusp (16/26) was noticed in 87 (56.86%) of Indo-Nepali and 45 (37.19%) of Tibeto-Nepali.<sup>5</sup> In the present study, Brahmins had the highest 77 (78.57%) and Muslims had the lowest 3 (42.86%) prevalence of cusp of Carabelli. Further research is needed to determine the relationship between the Carabelli cusp and ethnicity in the Nepali population.

## CONCLUSION

The prevalence of the cusp of Carabelli in the Maxillary first molar in Nepali Medical and dental students was higher compared to other populations. However full expression of a well-developed cusp was quite low in the present study. There was a minimal difference in the occurrence of Carabelli's cusp between males and females. Brahmins had the highest and Muslims had the lowest prevalence of cusp of Carabelli trait. Further studies are recommended to find the association of the cusp of Carabelli with ethnicity.

**Conflict of interest:** None.

## ACKNOWLEDGEMENTS

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