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Frequency of Carabelli's Cusp and its Association with Dental Caries in Maxillary Permanent First Molars in Relation to Gender

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ABSTRACT

Background: Carabelli's cusp is a hereditary trait on maxillary molars, often associated with increased dental caries risk, studied for its prevalence and implications across various populations. **Objective:** To investigate the prevalence of Carabelli's cusp and its correlation with dental caries in the upper first permanent molars, with a focus on gender differences. **Study Design:** Cross-sectional study design. **Settings:** The study was carried out at dental Department Rashid Latif Dental College, Lahore. **Duration:** From August 2021 to Jan 2022. **Methods:** Dental examinations identify the presence or absence of Carabelli's cusp in maxillary first molars, using a binary classification system (Present/Absent). Additional assessments include checking for dental caries associated with Carabelli's cusp. **Results:** The participants' ages varied from 11 to 30 years, with an average age of 21.60 ± 5.61 years. Out of 350 patients, CC on MPFM was observed in 115 (32.9%) patients, whereas it was absent in 235 (67.1%) patients. The distribution of the Cusp of Carabelli between genders did not exhibit a substantial disparity (p=0.278). There was a notable disparity in the laterality of the Cusp of Carabelli on MPFM between genders. In participants with the Cusp of Carabelli, 57.4% (n=66) had dental caries in the cusp groove, whereas 42.6% (n=49) did not (Table 5). 30 (26.1%) patients had right-sided caries in cusp of carabelli grove (CCG), 17 (14.8%) on the left, and 19 (16.5%) on both. The prevalence of dental caries in the Cusp of Carabelli groove did not significantly differ between genders (p=0.452). **Conclusion:** This study emphasizes the notable occurrence of Carabelli's cusp among young adults, emphasizing its possible influence in making persons more susceptible to dental caries.

Keywords: *Anthropology, Carabelli's cusp, Dental caries, Epidemiology, Maxillary molars preventive dentistry, Risk factors.*

INTRODUCTION

Carabelli's cusp is a variation in the structure that can be found on the mesiolingual side of the maxillary molars, most prominently on the first molars.[1] Recognized as a trait of significant hereditary influence, this cusp varies in prevalence and expression among different populations and Shows a significant correlation with tooth decay, specifically in the upper permanent first molars.[2] The cause of a Carabelli cusp is still unidentified. Both hereditary and external influences have been suggested. Genes associated with enamel formation, such as AMELX (amelogenin), and those involved in early craniofacial development, like MSX1 and PAX9, may influence the manifestation of Carabelli's cusp. These genes regulate morphological processes during tooth development, potentially leading to the formation of additional cusps on molars.[3,4]

The presence of Carabelli's cusp can complicate the oral hygiene process, potentially leading to increased plaque accumulation and a greater risk of dental caries. The morphological characteristics of the cusp, such as deep pits and fissures, may harbor bacterial colonies that contribute to the development of caries, highlighting the need for detailed studies into its pathophysiological impact.[5] Diagnosing Carabelli's cusp involves visual and tactile examination during routine dental check-ups.

Dentists assess the occlusal surfaces of the maxillary molars for the presence of this additional cusp, which may vary in size from a slight elevation to a fully developed cusp.[6] First described by Carabelli in 1842, the Carabelli's cusp has since become a focal point of extensive dental research exploring its morphology, anthropological significance, and genetic inheritance patterns. Its prevalence and morphological expression vary across different populations, making it a valuable marker for anthropological comparisons and for establishing phylogenetic links among closely related groups. While in some individuals the cusp is as prominent as the primary molars, in others it appears merely as a ridge, pit, or furrow. Notably, a rudimentary form of this structure, akin to the cingulum, has been observed in primate species such as apes and gibbons.[7]

The prevalence of Carabelli's cusp varies significantly across different regions, reflecting diverse genetic and environmental influences on this dental trait. In Madurai, India, a frequency of 72% highlights a strong genetic predisposition, while variations in primary and secondary teeth are documented at 38.75% and 23% respectively.[8,9] Iran reports an even higher prevalence of 96.6%, contrasting with Saudi Arabia's 41.7%.[10]

The objective of this study is to investigate the frequency and features of CC in Pakistan, where limited data exists on this dental trait, particularly in relation to dental caries and gender differences. By investigating these aspects, the study will provide new insights into the anthropological and clinical implications of Carabelli's cusp, enhancing the existing global literature with specific data from a South Asian context. Addressing this research gap will aid in better understanding genetic influences on dental morphology within Pakistani populations and contribute to more tailored dental care strategies regionally.

METHODS

This study was done in accordance with the ethical criteria outlined in the Declaration of Helsinki, and received clearance from the local Institutional Review Board (IRB/007/17). This cross-sectional study was conducted at dental department Rashid Latif Dental College, Lahore from August 2021 to Jan 2022. Prior to participating, all individuals provided informed consent, and confidentiality of the participant data was strictly maintained throughout the study. Participants were selected based on a convenience sampling technique. The WHO calculator was used to figure out that the sample size should be 350 cases (www.openepi.com, version 3) taking frequency of carabelli trait to be 53.75% on prior research, a significance level (α) of 0.05, and a power of 80%.

Participants aged 11 to 30 years with at least one fully erupted maxillary permanent first molar were included. Individuals with extensive orthodontic treatments, congenital craniofacial anomalies, systemic diseases affecting dental health, or unable to comply with examination procedures were excluded to ensure clear assessment of Carabelli's cusp and associated dental caries.

Demographic data including age and gender were collected through structured medical records. Dental examinations were performed by qualified dentists using standardized dental examination tools to determine whether Carabelli's cusp is present or absent on maxillary permanent first molars. Each tooth was assessed for the incidence of CC, which was categorized based on its physical manifestation—either present or absent.

The dentists conducted detailed oral examinations, the objective is to examine the maxillary first molars for the identification of Carabelli's cusp and determine whether it is present unilaterally or bilaterally. The criteria for identifying Carabelli's cusp involved observing any raised or prominent cusp-like structures on the mesiolingual surface of the first molars. Additionally, the same molars were inspected for signs of dental caries within the groove of Carabelli's cusp, with findings categorized as present or absent. Any elevation or identifiable morphological characteristic on the mesiolingual surface of the maxillary permanent first molars indicates a "Present" cusp. Otherwise, it will be labeled as "Absent."

The data that was gathered was analysed using IBM SPSS, specifically version 27.0. The Chi-square test is used to compare categorical variables, which are generally reported in the form of frequency and percentage. The mean and standard deviation (SD) are the methods that are used to express continuous variables. The level of significance was established at 5%, and a p-value of less than 0.05 (with a 95% confidence interval) was deemed statistically significant

RESULTS

The study included a total of 350 participants, comprising 200 females (57.1%) and 150 males (42.9%) as revealed in Table 1. The participants' ages varied from 11 to 30 years, with an average age of 21.60 ± 5.61 years. A significant proportion of the participants, specifically 212 individuals (60.6%), belonged to the age group of 21-30 while the remaining 138 (39.4%) were in the 11-20 age group.

Table 1: Age & gender distribution of study participants

Variables	Category	N(%)
Gender	Female	200(57.1%)
	Male	150(42.9%)
Age (years)	11-20	138(39.4%)
	21-30	212(60.6%)
	Mean ± SD	21.60 ± 5.61

Cusp of Carabelli (CC) was present in 32.9% of 350 patients, with 75.7% showing bilateral presence and 24.3% unilateral presence. Among unilateral cases, 8.7% had the cusp on the left molar only, and 15.7% on the right molar only given in table 2.

Table 2: Frequency of CC on MPFM

Variables	Category	N (%)
Cusp of Carabelli	Present	115(32.9%)
	Absent	235(67.1%)
Laterality	Right	18 (15.7%)
	Left	10 (8.7%)

The Cusp of Carabelli distribution showed no significant gender difference (p=0.278), with 47.0% prevalence in males and 53.0% in females. However, males had a higher bilateral prevalence (52.9%) than females (47.1%), while unilateral presence was more common in females (71.4%) compared to males (28.6%), indicating a significant difference in laterality (p=0.025) given in table 3.

Table 3: Contrast of frequency of CC among both genders

Gender	Cusp of Carabelli		p -value
	Present(n=115)	Absent(n=235)	
Male	54(47%)	96(40.9%)	0.278
Female	61(53%)	139(59.1%)	
Gender	**Unilateral(n=28)**	**Bilateral(n=87)**	**p-value**
Male	8(28.6%)	46(52.9%)	0.025
Female	20(71.4%)	41(57.1%)	

The occurrence of dental caries in the Cusp of Carabelli groove did not significantly differ between genders (p=0.452). Among males, 29 (43.9%) had caries present and 25 (51.0%) absent. For females, the corresponding figures were 37 (56.1%) for caries present and 24 (49.0%) absent.

Table 4: Gender-based comparison of dental caries in CC groove in MPFM

Gender	Dental carries in CC Groove		p value
	Present (n=66)	Absent(n=49)	
Male	29(43.9%)	25(51%)	0.452
Female	37(56.1%)	24(49%)	

DISCUSSION

This cusp is most commonly found on the maxillary first molars and is seldom observed on the third molars.[11] The objective of our study was to assess the frequency of the CC and its correlation with dental caries in the upper permanent first molars.

In our study, the cusp of carabelli was reported by 57.1% of female patients, whereas the occurrence rate among male patients was comparatively lower at 42.9%. The findings were consistent with the research undertaken by Arbab *et al*. (2021), which documented a higher prevalence of females (58.33%) compared to males (41.67%).[12] In another study carried out by Subedi *et al*. (2015) also showed that females (51%) are more compared to males (49%).13 The study included participants aged 11 to 30 years, with a mean age of 21.60 ± 5.61 years. Arbab *et al*. (2021) found that the age of the participants in their study ranged from 13 to 30 years, with a mean age of 22.46 ± 5.1 years. This is similar to the age range observed in our study.[12]

In this study, CC on MPFM was observed in 32.9% of patients. These findings were comparable with the study conducted by Dabholkar *et al*. (2021) and Qamar *et al* (2018)[9] who reported cusp of carabelli in 32.85% and 32% patients respectively.[12,15] A study conducted in Khyber Pakhtunkhwa by Khan *et al*. (2011) found a prevalence rate of 29.7% for CC, which was greater than the prevalence rate observed in our study.[16] Similar study by Kannapan *et al*. (2001) described greater rates of incidence of the CC on MPFM (52.77%).[17] In our study, CC on MPFM was more dominant in females (53%) compared to males (47%) with no significant findings. Niazi *et al*. (2016) also reported higher incidence of cusp of carabelli in females (57.6%) compared to males (42.4%).[18] But Dabholkar *et al*. (2021) and Qamar *et al* (2018) reported higher incidence of cusp of carabelli in males (53% and 69% respectively), which contrast with our study.[14,15]

In this study, bilateralism was seen in 75.6% cases, while unilateralism was seen in only 24.4% cases. Studies by Arbab *et al*. (2021) and Niazi *et al*. (2016)[13] reported higher rate of bilateralism of 62.8% and 75.1% respectively which was comparable with our study.[12,18] These findings align with the research conducted by Shethri *et al*. (2011)[14], Edgar *et al*. (2009)[15], and Dabholkar *et al*. (2021)[8], which reported bilateral presence of the Carabelli cusp in proportions of 82.2%, 75.6%, and 88.1% correspondingly.[14,19,20] Also, bilateralism was more common in males (52.9%) compared to females (47.1%). These results were reliable with the results of Dabholkar *et al*. (2021) who also showed that bilateralism was more common in males (52.8%) compared to females (47.2%).[14]

In this study, 57.4% of patients with the CC had dental caries in the cusp of carabelli groove (CCG). Shethri *et al*. (2011) demonstrated that the prevalence of in CCG was 16.8%, whereas Tangade *et al*. (2011) detected the presence of carious lesion in CCG in 18.1% of patients who were on the verge of carabelli.[19,21]

CONCLUSION

This study emphasizes the notable occurrence of Carabelli's cusp in young adults, highlighting its possible influence in making individuals more susceptible to dental caries.

LIMITATIONS

The study exclusively concentrated on doing intraoral examinations of the subjects, without utilizing radiography or dental casts.

SUGGESTIONS / RECOMMENDATIONS

Future studies should explore factors influencing Cusp of Carabelli.

CONFLICT OF INTEREST / DISCLOSURE

None.

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