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Morphological Prevalence and Clinical Implications of the Cusp of Carabelli in Maxillary First Molars: A Cross-Sectional Study among the Bangladeshi Population

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Abstract | **Original Research Article**

Background: The Cusp of Carabelli is a morphological variant located on the mesiopalatal surface of maxillary first molars, ranging from shallow grooves to prominent cusps. Its prevalence varies across ethnic groups and may contribute to clinical issues such as plaque retention, caries, aesthetic concerns, and occlusal complications. However, data on its prevalence and clinical relevance in the Bangladeshi population are limited. ***Objectives:*** This study aimed to determine the prevalence, morphological variations, and clinical implications of the Cusp of Carabelli in maxillary permanent first molars among Bangladeshi individuals, with particular focus on caries and occlusal effects. ***Methods:*** A cross-sectional study was conducted at BSMMU and Dhaka Dental College, involving 1,000 participants aged 8–40 years. Clinical examinations were performed by two calibrated examiners to assess the presence, morphology, carious involvement, and occlusal contact of the cusp. Data were analyzed using SPSS; associations were tested using chi-square tests ($p < 0.05$). ***Results:*** The Cusp of Carabelli was observed in 41.2% of participants, predominantly bilaterally (83%). Among those with the cusp, 25.7% had carious lesions, mostly located near the cusp. Occlusal contact on the cusp was noted in 8.3%, but no significant wear or interference was found. A statistically significant association was observed between caries and occlusal contact ($p = 0.02$). No significant variation in prevalence was found across age or sex groups. ***Conclusion:*** The Cusp of Carabelli is common in the Bangladeshi population and associated with increased caries risk, warranting preventive attention during routine dental care.

Keywords: Cusp of Carabelli, Maxillary first molars, Prevalence, Dental morphology, Occlusal contact, Dental caries, Bangladeshi population, Occlusal interference, Wear facets.

INTRODUCTION

Since its initial thorough description by Georg Carabelli in 1842, the Cusp of Carabelli—a supplementary cusp that is usually found on the mesiopalatal surface of maxillary permanent first molars—has attracted attention from both clinical and anthropological fields [1,2]. With a prevalence that ranges from 20% to 90% worldwide, this morphological variation shows significant diversity across populations. Up to 90% of European populations have it, compared to 50% to 60% of South Asian and Middle Eastern populations, and 0% to 20% of Arctic and East Asian populations [3–6]. Although the precise pattern of inheritance is still unknown, these variations highlight a significant genetic influence that is probably polygenic in nature [7, 8].

According to studies, the prevalence in Bangladesh is roughly 53%, with a slightly higher frequency in females [9]. The Cusp of Carabelli has been linked to heightened vulnerability to dental caries, especially in the grooves surrounding the cusp, despite being conventionally regarded as a non-functional characteristic [10]. Data on its clinical effects in the Bangladeshi population is still lacking, though, especially with regard to how it affects occlusal function, the risk of cusp fracture, and possible soft tissue irritation.

Regular screening for the Cusp of Carabelli during dental examinations is advised for practitioners in Bangladesh due to its moderate prevalence and potential clinical consequences, such as occlusal disharmony and caries susceptibility. This cross-sectional study intends to assess the clinical significance and morphological prevalence of the Cusp of Carabelli in maxillary first molars in the Bangladeshi population in order to fill in current gaps. It is anticipated that the results will influence clinical practice and direct strategies for preventive care. Additionally, raising awareness of these morphological variations in dental education can help with treatment planning and diagnostic precision.

MATERIALS AND METHODS

From January to December 2024, BSMMU and Dhaka Dental College carried out a cross-sectional study. Based on sample size calculations, 1,000 participants were chosen by simple random sampling from 2,455 eligible individuals with fully erupted maxillary first molars who were between the ages of 8 and 40. Through clinical examinations and a validated questionnaire, two calibrated examiners evaluated the presence and morphology of the Cusp of Carabelli (using Dahlberg's classification), dental caries (WHO criteria), occlusal contact (articulating paper), malocclusion (Angle's classification), tongue irritation, and cusp fractures. Standardised forms were used to record the data, and SPSS v26.0 was used to analyse the data using logistic regression and chi-square ($p < 0.05$). Confidentiality and the Declaration of Helsinki guidelines were adhered to, and ethical approval and informed consent were acquired.

RESULTS

One thousand participants with fully erupted maxillary first molars, ages 8 to 40, were included in the study. 41.2% of people had the Cusp of Carabelli, with 83% of those cases being bilateral. Of those with the cusp, 25.7% had carious lesions. There were no instances of occlusal interference or wear facets, and 8.3% of patients had occlusal contact on the cusp. Occlusal contact and caries were found to be significantly correlated ($p < 0.05$). There were no discernible variations in prevalence between age or sex groups. The tables and figures that go with the results provide more specific information.

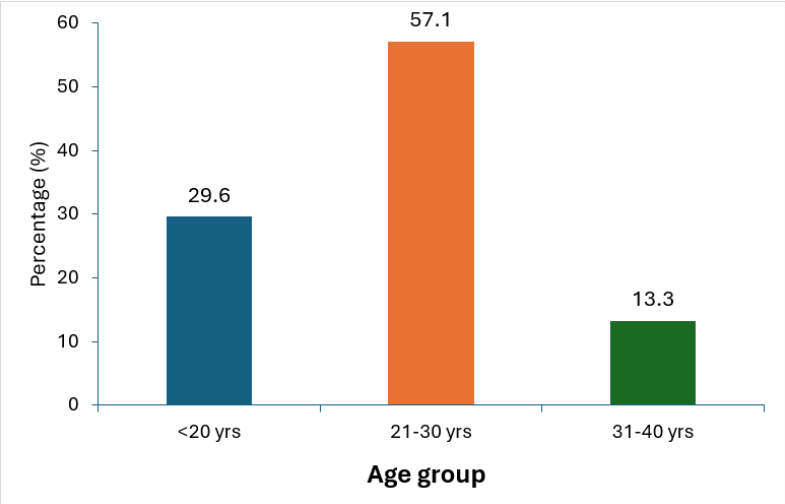

Figure 1: Distribution of participants by age group

The percentage distribution of 1,000 participants by age group is displayed in Figure 1. The largest group was those aged 21 to 30 (57.1%), followed by those aged under 20 (29.6%) and 31 to 40 (13.3%). This distribution shows that young adults make up the majority of the sample, which could have an impact on the reported prevalence and clinical findings.

Table I: Distribution of the study prevalence of cusp of Carabelli (N=1000)

Cusp of Carabelli	Frequency	Percentage (%)
Present	412	41.2
Absent	588	58.8
Total	**1000**	**100.0**

Table I shows that 41.2% of the 1,000 people who took part had the Cusp of Carabelli. The other 58.8% did not have a cusp. Laterality and demographic factors are looked at more closely in the tables that follow. This level of prevalence is in line with what has been seen in other South Asian groups.

Table II: Distribution of the study by dental carries among the study subjects (N=412)

Dental caries	Frequency	Percentage (%)
Yes	106	25.7
No	306	74.3
Total	**412**	**100.0**

Table II shows that 25.7% of people with the Cusp of Carabelli had cavities. This shows that this group has a high rate of caries, which will be compared to people who don't have the cusp in more detail to see if they are at risk.

Table III: Distribution of the study by history of accidental cusp fracture, any irritation of tongue, and malocclusion among the study subjects (N=412)

	Frequency	Percentage (%)
History of accidental cusp fracture		
Yes	0	0.0
No	412	100.0
Presence of any irritation of tongue due to this Cusp		
Yes	0	0.0
No	412	100.0
Presence of malocclusion due to this Cusp		
Yes	0	0.0
No	412	100.0

Table III shows that none of the participants with the Cusp of Carabelli had any accidental cusp fractures, tongue irritation, or malocclusion. These results suggest that these clinical problems are uncommon or don't happen at all in this group of people, but more research may be needed to confirm this.

DISCUSSION

The study found that 41.2% of Bangladeshi patients had the Cusp of Carabelli (CC), which is consistent with other studies in the area and shows how different ethnic groups are around the world. The fact that most of the expressions were bilateral (83%) supports what we already know about the strong genetic component that affects this dental trait. The fact that CC prevalence is not strongly linked to demographic factors like age and sex supports the idea that this morphological trait is mostly determined by genetics and not by environmental factors [11-13].

A significant finding was that 25.7% of people with the cusp had dental caries, which suggests a mild but clinically relevant link. This backs up earlier research that says the grooved shape of the CC can make places where plaque can build up, which raises the risk of cavities [14, 15]. But it's important to remember that caries development is caused by many things, such as oral hygiene, diet, saliva composition, and socioeconomic factors [16]. This study didn't control for any of these factors. To better understand the cusp's independent effect on caries susceptibility, future studies should include these variables [17, 18].

This group did not have any functional problems like occlusal interference, cusp fractures, tongue irritation, or malocclusion, which supports the idea that the CC is mostly a non-functional anatomical variation [19]. This result is in line with other studies that say the cusp is a morphological trait that doesn't have much of an effect on occlusion or soft tissues. Still, it shouldn't be ignored during dental exams because its link to cavities means it needs to be watched closely and prevented [20].

The study's cross-sectional design makes it hard to draw conclusions about cause and effect, and the sample, which came from hospital outpatient settings, may not be a good representation of the general population. Some clinical findings may not be as reliable because there are no details about how the examiners were calibrated and there may be an underreporting of soft tissue symptoms. Even with these problems, the study gives us useful baseline information about the people of Bangladesh.

The Cusp of Carabelli is a common trait that mostly affects both sides of the mouth and doesn't have much of an effect on how well the teeth work. However, its possible role in raising the risk of cavities should be looked into. Dentists should include its assessment in regular clinical evaluations and stress preventive care for patients who have it. To better understand how this cusp affects different populations, more long-term, multicenter research that looks at both genetic and environmental factors is needed.

CONCLUSION

This study confirms that the Cusp of Carabelli is a common morphological trait in the Bangladeshi population, mostly on both sides, and has little effect on how the teeth fit together. But its anatomical grooves may make it more likely to get cavities, which shows how important it is to do a thorough clinical exam and provide targeted preventive care. Adding morphological differences like this to oral health assessments can help find people who are at risk. We need more community-based and long-term studies in the future to better understand its clinical importance and how to manage it.

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