INFLUENCE OF CUSP OF CARABELLI TRAIT FOR UPPER 1ST MOLAR EXTRACTION AND ITS ETHNIC ASSOCIATION FOR FORENSIC ODONTOLOGY IN TERTIARY CARE UNIT

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Abstract

Introduction: Scientifically and practically, morphological variances in tooth structure have always attracted the dentist's attention. The expression of varying cuspal traits that elicit distinct characteristics has beneficial tool for categorizing the population. The Cusp of Carabelli(COC) changed the tooth dimension, making forceps adaptation more difficult.

Objective: The purpose of this study is to see if there's a link between the COC trait and upper 1st molar teeth extraction in the Pakistani urban population of Karachi. This could be a useful criterion for forensic odontology and person identification.

Methodology: A cross-sectional study was carried out on total of 650 dental casts models of individuals seeking orthodontic treatment. Our parameter was to examine the presence of COC of maxillary first permanent molar and its forensic odontology. Among them, 75 patients came for tooth extraction of 1st carious maxillary molar.

Results: This study exhibited that COC changes the tooth dimension, making tooth extraction more difficult. The COC were 44% moderate tubercle, 27.1% smooth, 27.2% small tubercle, and 1.7% greater tubercle.

Conclusion: There is a link between COC and tooth extraction difficulty due to forceps adaption difficulties. Apart from that, it might be useful in determining an individual's ethnic origin.

Keywords; Cusp of Carabelli; Cuspal variations; Forensic odontology; Mesiopalatal

1. INTRODUCTION

The phrase "dental anthropology" refers to the study of the origins and variations of the human dentition. It's a quick way to classify geographic or racial affinities[1].Dento-anthropologic structures like as cusp size, number, and location, occlusal pattern, root architecture, number and arrangement of teeth, and individual tooth dimensions can all aid in identification[2].

The Carabelli structure is a tubercle, cuspule, or groove on the palatal surface of the mesio-palatal cusp of maxillary permanent molars and maxillary second deciduous molars[3]. It can appear in a variety of ways, including pits, grooves, tubercles, cusplets, or cusps[4]. It is the result of a complex system of ontogenetic and environmental elements interacting with one another[5].

The occurrence of the Carabelli cusp was investigated in 233 patients in a Finnish rural community by Alvesalo et al. (1975)[6]. The cusp in the first upper molars was present in 79% of them. The structure appeared bilaterally, with various degrees of asymmetry. Their findings suggested that the character has a low heritability. The Carabelli structure was classed as follows:

1. Smooth surface.
2. Single pit or furrow.
3. Double furrow or Y-shaped furrow.
4. Slight protuberance or small cusp.
5. Large cusp.

Similarly, 320 maxillary casts of Malaysian children were tested for the presence of the Carabelli characteristic on the maxillary first permanent teeth in a study undertaken by the Rusmah (1992)[7]. A total trait frequency of 51.6 percent was discovered. The cusp was found to be bilateral in the majority of cases.

The Carabelli trait (Fig 1) was initially assessed for 382 patients using Dahlberg's (1963)[8] technique, which uses a ranking scale that includes absence and seven degrees of presence ranging from single grooves and pits to double and Y-shaped grooves to variable cusp widths, utilises a rating scale that includes absence and seven degrees of presence. The use of a plaster duplicate of Dahlberg's standard plaque aided classifications, despite the fact that this procedure is subjective.

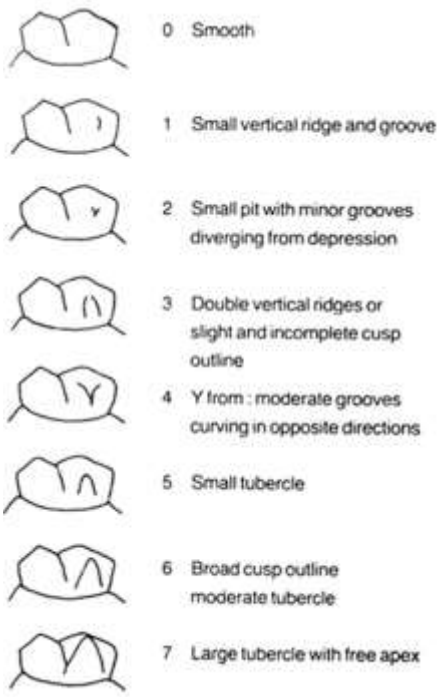


Figure 1: Dahlberg's (1963) scale for the determination of degree and expression of Carabelli cusps[9]

To date, such studies have not been found in the literature to evaluate the occlusal surface of mandibular second premolar teeth (cusp pattern, number of cusps, occlusal fossa, and connection of enamel ridge) of the Pakistani individuals.

The present study aims to evaluate the prevalence and degree of expression of the Carabelli structure in the permanent maxillary first molars in the selected subset of the Pakistani urban population belonging to the city of Karachi. The objective of this study was to discern the ratio of ethnic differences in the Karachi population that could be used for identification, medico-legal purposes, and forensic odontology. Also find out the difficulties that faced during extraction of teeth having expression of the Carabelli.

2. MATERIAL AND METHODS

This was a multi-center cross-sectional analytical study carried out on stone models of individuals seeking orthodontic treatment. The data was derived from 650 orthodontic study casts, permission have been taken from Head of Departments, samples coming for routine investigation in department of orthodontics at Dr. Ishratul Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, and Department of Orthodontics at Fatimah Jinnah Dental College, Karachi. Ethical approval for this study has been sought from the Institutional Review Board of Dow University of Health Sciences.

Among 650 patients about 105 patients had clinical indications for tooth extraction, but only 75 patients filled the informed consent for enrollment in our study for evaluation of adverse effects during tooth extraction.

Inclusion criteria: Only those maxillary and mandibular casts which had fully erupted and bilaterally present permanent mandibular second premolars and permanent maxillary first molars were selected. Casts were selected which showed excellent clarity of detail and where the teeth were not deformed and showed no mechanical fracture or caries. Subjects' ages range from 15-30 years old. Teeth assessed to be morphologically normal and for the absence of any attrition, erosion & abrasion.

Exclusion Criteria: Tooth having attrition, abrasion, erosion. Missing permanent first maxillary molar tooth, unilaterally or bilaterally. Loss of morphological features. Fractured crown.

Cast Analysis: Casts were analyzed under dental unit light to observe visually the different groove patterns and cusp types and to visualize the degree of the cusp of Carabelli expression. A single examiner reviewed and recorded the cuspal variety of mandibular premolars and degree of expression of the Carabelli trait by the classification developed by Kraus and standards developed by Dahlberg.

3. STATISTICAL ANALYSIS

Sample size was calculated through OpenEpi version 3.0 taking the 50.34% (International Journal of Odontostomat., 6(3):375-377, 2012, 99% of Confidence Level and 5 % of Confidence limits. The calculated sample size was 650.

4. RESULTS

In this study, a total of 650 subjects were examined 255 (39.2%) were males and 395 (60.8%) were females. According to age groups, 16-20-year-old subjects were 339 (52.2%), 21-25 years old were 213 (32.8%), 26-30 years old subjects were 98 (15.1%). As depicted in table 1.

Table 1: Demographic characteristics of studied populations

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">N(%)
N=650</th></tr>
<tr><td>Gender</td><td>Male
Female</td><td colspan="2">255 (39.2)
395 (60.8)</td></tr>
<tr><td>Age (years)</td><td>16-20
21-25
26-30</td><td colspan="2">339 (52.2)
213 (32.8)
98 (15.1)</td></tr>
<tr><td rowspan="6">Ethnic distributions</td><td rowspan="2">Pathan</td><td>Moderate</td><td>Large</td></tr>
<tr><td>153 (23.54)</td><td>09 (1.38)</td></tr>
<tr><td rowspan="2">Balochi</td><td>Moderate</td><td>Large</td></tr>
<tr><td>133 (20.46)</td><td>02 (0.31)</td></tr>
<tr><td>Sindhi</td><td colspan="2">Small / Smooth
113 (17.38)</td></tr>
<tr><td>Punjabi</td><td colspan="2">Small /Smooth
30 (04.62)</td></tr>
<tr><td>Urdu Speaking</td><td colspan="2">Small / Smooth
210 (32.31)</td></tr>
</table>

Ethnic distributions show among 650 dental casts about 162 patients were Pathan and among them, about 23.54% had moderate tubercle and 1.38% had large tubercle. Similarly among 650 patients about 135 patients were Balochi and among them, 20.46% had Moderate tubercle and only 0.31% had large tubercle. About 113 patients were Sindhi and all patients had smooth tubercles. Similarly, about 30 patients were Punjabi and 210 patients were Urdu speaking and all of them also had Small/smooth tubercles. As shown in table 1.

The cusp of Carabelli was found to be, according to Dahlberg classification; smooth 176 (27.1%), small tubercle 177 (27.2%), broad cusp outline moderate tubercle 286 (44%), large tubercle with free apex 11 (1.7%). Among the studied subjects, a total of 2cusp variety was found 519 (79.8%) and 3 cusp variety was found 131 (20.2%). As shown in table 2. Tooth dimensions were 7.35±0.11, 7.74±0.13, 8.34±0.13, and 9.12±0.30 of Smooth, Small tubercle, moderate tubercle, and Large tubercle respectively. As depicted in table 3.

Table 2: Different variations of Cusp of Carabelli according to Dahlberg classification

	Cusp types and variations	**N (%) N=650**
Cusp types	**Smooth**	176 (27.1)
	Small tubercle	177 (27.1)
	Broad cusp outline moderate tubercle	286 (44.0)
	Large tubercle with free apex	11 (1.7)
Cusp Variations	**2 Cusp**	519 (79.8)
	3 Cusp	131 (20.2)

Table 3: Tooth dimensions with Cusps of Carabelli

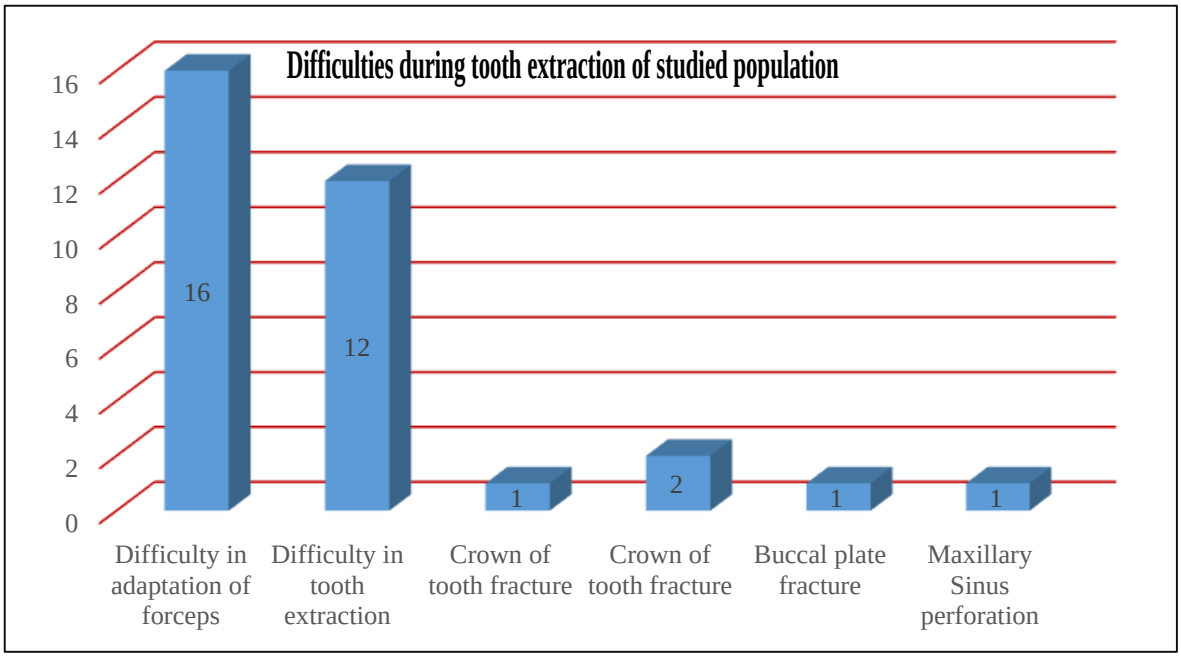
	Cusps of Carabelli types	**N**	**Mean±SD N=650**
Cusp types	**Smooth**	176	7.35±0.11
	Small tubercle	177	7.74±0.13
	Broad cusp outline moderate tubercle	286	8.34±0.13

	Large tubercle with free apex	11	9.12±0.30

Among 75 patients that enrolled for tooth extraction shows Difficulty in the adaptation of forceps in about 21.33 %, Difficulty in extraction in 16%, Crown of tooth fracture in 1.33%, Root fracture 2.67%, Buccal plate fracture 01.33%, and Maxillary Sinus perforation in 1.33% of patients. As depicted in table 4.

Table 4: Difficulties during tooth extraction of studied population

Difficulties	**N (%) N=75**
Difficulty in adaptation of forceps	16 (21.33)
Difficulty in extraction	12 (16.00)
Crown of tooth fracture	01 (01.33)
Root fracture	02 (02.67)
Buccal plate fracture	01 (01.33)
Maxillary Sinus perforation	01 (01.33)



DISCUSSION:

The cusp of carabelli in maxillary first permanent molars presents either as a proper non-functional cusp located just inferior to the mesio-lingual cusp or it presents either as a small tubercle and finally as an indistinct groove. Its variable appearance in different racial groups and ethnicities has been linked contemporarily to evolution and function [10].

Clinical significance of the Carabelli trait includes identification of maxillary molars in forensic odontology for matching antemortem and postmortem dental records. However, difficulties arose due to the adaptation of prefabricated molar bands in fixed orthodontics resulting in potential gaps in these molar bands, which are subsequently filled by plaque and food debris leading to caries and gingivitis[11].

The trait of Carabelli being an identifying and distinguishing characteristic of maxillary molars can be used for clinical, anthropological, and forensic purposes[12]. Limited regional studies are available on the prevalence and degree of expression of Carabelli in Pakistan & South East Asia.

In this study, we evaluate the ethnic association of the cusp of Carabelli and difficulties faced during extraction of 1st molar tooth with the cusp of Carabelli trait among the population of Karachi in the tertiary care unit.

In the present study as compared to males, female patients have shown more variation in the cusp of carbelli, about 60.8%. This was in line with the study conducted by Niazi et al., (2016)[13]. As they show that about 54% of female shows variation in the cusp of Carabelli. But this was in contrast with the study conducted by Khan et al., (2011)[14], who found that more males had Cusp

of Carabelli (31.5%) than females (26.5%). They noted just the presence and absence of Cusp of Carabelli bilaterally but did not follow the degree of expression of the Carabelli trait, per the classification developed by Kraus and standards developed by Dahlberg.

In our study, the most variation according to Dahlberg was Smooth (27.1%) and Small tubercle (27.1%) followed by Broad cusp outline moderate tubercle (44.0%) but only 1.7 % shows large tubercle with free apex. This was in line with the study conducted by Saravannan (2020)[15]. This study was to determine the prevalence of the cusp of carabelli among children in the Madurai population. This study shows that according to Dahlberg classification type 2 and 3 (Small tubercle) were more frequently present in the studied population and the least one is type 6 (Large Tubercle).

In our study Ethnic association shows that among 650 dental casts about 162 patients were Pathan and among them mostly had moderate tubercle about 153 patients and only 9 patients had large tubercle. Similarly among 650 patients about 135 patients were Balochi and among them, 20.46% had Moderate tubercle and only 0.31% had large tubercle. About 113 patients were Sindhi and all patients had smooth tubercles. Similarly, about 30 patients were Punjabi and 210 patients were Urdu speaking and all of them also had Small/smooth tubercles. Kirthiga et al., (2016)[16]. As they evaluated the ethic association of Cusp of Carabelli trait in Indian populations.

In our study in about 75 patients, we assessed the difficulties faced during the upper 1st molar tooth extraction having cusp of Carabelli trait. The most common difficulties that faced were Difficulty in the adaptation of forceps in about 21.33 % and Difficulty in extraction in 16%. This was in line with Khan et al., (2011)[14]. As they show that the usually used molar extraction forceps have no accommodation for the cusp of Carabelli which results in difficulty in forceps adaptation and even result in fracture of teeth.

In clinical dentistry, industry (for producing equipment and dental materials), forensic odontology, and anthropology, tooth morphology are essential. Orthodontists routinely employ manufactured molar bands that have no correction for the cusp of the carabelli, resulting in a loose fit[17]. As a result, food debris and bacteria fill the area left between the band and the tooth, resulting in early caries and periodontal disease[18].

5. CONCLUSION

Analysis of dental morphology for Expression of the cusp of carabelli in maxillary first permanent molar and cuspal variations with different groove patterns in mandibular second premolar appears to be a beneficial tool for forensic odontology. Large scaled studies would be helpful to define its medico-legal implications.

References

1. Rathmann H and Reyes-Centeno H. Testing the utility of dental morphological trait combinations for inferring human neutral genetic variation. PNAS. 2020; 117(20):10769–10777.

2. Nair S, Vijayalakshmi S. Kotrashetti, Nayak R and Hosmani J. Occlusal groove patterns and cusp number in permanent mandibular first and second molar among Indian population - A pilot study. Journal of Advanced Clinical & Research Insights.2018; 5(4):115–118.

3. Kirthiga M, Manju M, Praveen R, Umesh W. Ethnic Association of Cusp of Carabelli Trait and Shoveling Trait in an Indian Population. J Clin Diagn Res. 2016; 10(3):ZC78-ZC81.

4. Al Shethri S. The prevalence of the Carabelli cusp in selected Saudi population. King Saud University Journal of Dental Sciences; 20112(1-2):13-16.

5. Biggerstaff RH. Heritability of the Carabelli cusp in twins. J. Dent. Res.1973; 52 (1): 40–44.

6. Alvesalo L, Nuutila, M, Portin, P. The cusp of Carabelli. Occurrence in first upper molars and evaluation of its heritability. Acta Odontol. Scand. 1972;33 (4): 191–197.

7. Rusmah M. The cusp of Carabelli in Malaysians. Odontostomatol. Trop. 1992;15 (1):13–15.

8. Dahlberg A. A. 1963. Analysis of the American Indian dentition. In: Denrul Anrhropolog! (Edited by Brothwell D. R.) pp. 1499177. Perpamon Press. Oxford.

9. Mosharraf R. Prevalence of the carabelli trait in Iranian adolescents. SRM J Res Dent Sci 2013; 4:12-15.

10. Sarpangala M, Devasya A.Occurrence of Cusp of Carabelli in Primary Second Molar Series of three Cases.J Clin of Diagn Res.2017; 11(3):ZR01-ZR02.

11. Kamatham R, Nuvvula S. Expression of Carabelli trait in children from Southern India - A cross sectional study. J Forensic Dent Sci. 2014; 6(1):51-57.

12. Smitha T, Venkatesh D, Veeresh M, Hema KN, Sheethal HS, Vidya MA. The cusp of Carabelli: Frequency, distribution and type in the Bengaluru population. J Oral Maxillofac Pathol. 2018; 22(3):418-422.

13. Niazi M, Najmi, Y, & Qadri, MM. Frequency of cusp of carabelli in orthodontic patients reporting to Islamabad Dental Hospital. Pakistan Orthodontic Journal.2016; 8(2), 85-88.

14. Khan DB, Khan MA and Khattak M. Prevalence of cusp of carabelli in permanent teeth in a Group from Khyber Pakhtunkhwa, Pakistan. Pakistan Oral & Dental Journal.2011; 31 (2):409-411.

15. Saravanan R. Prevalence of cusp of Carabelli in Madurai population. Int J Recent Sci Res.2020; 11(06):38805-38807.

16. Kirthiga M, Manju M, Praveen R, Umesh W. Ethnic Association of Cusp of Carabelli Trait and Shoveling Trait in an Indian Population. J Clin Diagn Res. 2016; 10(3):ZC78-ZC81.

17. Krishan K, Kanchan T, Garg AK. Dental Evidence in Forensic Identification - An Overview, Methodology and Present Status. Open Dent J. 2015; 9:250-256.

18. Reddy G, Reddy VP, Sharma M, Aggarwal M. Role of Orthodontics in Forensic Odontology- A Social Responsibility. J Clin Diagn Res. 2016; 10(4):ZE01-ZE3.