

## **Evaluation of Cusp of Carabelli and Sexual Dimorphism in Permanent Maxillary First Molar: A Study of Udaipur Population**

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**Citation of this Article:** Dr. Samiha Bari, Dr. Rashmi Metgud, “Evaluation of Cusp of Carabelli and Sexual Dimorphism in Permanent Maxillary First Molar: A Study of Udaipur Population”, IJDSIR- May - 2020, Vol. – 3, Issue -3, P. No. 133 – 138.

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**Type of Publication:** Original Research Article

**Conflicts of Interest:** Nil

### **Abstract**

**Background:** Identifying sex of skeletal remains is an important step in building the biological profile of unidentified skeletons recovered in forensic context, enabling search of missing person’s files and recovering ante mortem records for comparisons or establishing identity. Teeth are one of the strongest human tissues and are known to resist a variety of ante and post mortem insults. Sexual dimorphism refers to those differences in size, stature and appearance between male and female that can be applied to dental identification as no two mouths are alike.

**Aim:** To evaluate the presence of cusp of Carabelli and sexual dimorphism in permanent maxillary first molars by recording the mesiodistal (MD) and buccolingual (BL) diameters using digital vernier calipers.

**Materials and Methods:** The study comprised of 200 subjects (100 males and 100 females) aged 11-40years. The presence of cusp of Carabelli and MD and BL diameters of maxillary first molars on study casts were recorded.

**Results:** The MD and BL diameters were higher in males than females. About 39% of Udaipur population showed the presence of Cusp of Carabelli, with males having a slight higher percentage (40%) than females (38%).

**Keywords:** Cusp of Carabelli, Sexual Dimorphism, Permanent Maxillary First Molar, Udaipur

### **Introduction**

Over recent years, thousands of people have migrated to different parts of world. In 2010 the estimated number of international migrants was 215.8 million (of which 16.3 million were refugees), an increase of 35 million since 2000 and 58 million since 1990.<sup>[1]</sup>

This increasing migration has led to problems related to human rights, public health, disease and border control, and also to the regulatory processes. From a forensic point of view there is need for a comprehensive approach with regards to personal identification. Human identification is the recognition of an individual based on the physical characteristics that are unique for an individual.

Identifying the sex of skeletal remains is an important step in building the biological profile of unidentified skeletons recovered in forensic contexts, enabling search of missing person files and recovering antemortem records for comparison or establishing identity. The most reliable results obtained are from morphological and metric analysis of the bony pelvis and skull.<sup>[2,3]</sup>

Measurements of the long bones, particularly those of the femur and humerus, may also provide highly accurate sex assessments. It is often the case in forensic practice that the only available criterion for determining sex is measuring the permanent dentition since the teeth are more resistant to taphonomic degradation and postmortem insults than any other skeletal structures.<sup>[4]</sup> Sex determination using dental features is primarily based upon the comparison of tooth dimensions in males and females or upon the comparison of frequencies of non-metric dental traits like Carabelli's trait of upper molars, deflecting wrinkle of the lower first molars, distal accessory ridge of the upper and lower canines or shovelling of the upper central incisors.<sup>[5]</sup> This is based on the fact that although the morphology of the tooth structure is similar in males and females, the size of the tooth does not necessarily remain the same, as the tooth size is determined by cultural, environmental, racial and genetic factors. 'Sexual dimorphism' refers to those differences in size, stature and appearance between male and female that can be applied to dental identification because no two mouths are alike.<sup>[4]</sup>

## Materials and Methods

The study comprised of 200 maxillary casts (100 males and 100 females) of an age group of individuals ranging from 11-40 years which were selected from Department Of Orthodontics, Pacific Dental College and Hospital, Udaipur, India.

This particular age group was studied as ante-mortem insults such as attrition and abrasion affecting occlusal and approximal tooth surfaces are minimal. The inclusion criteria was presence of normal teeth and presence of bilateral maxillary first molars. The presence and absence of Cusp of Carabelli was also considered.

The MD and BL diameters of the maxillary first molars were measured using digital vernier calipers (resolution 0.01mm) on study casts.

- BL diameter: is the greatest distance between buccal and lingual surfaces of the crown, taken at right angles to the plane.(Fig. 1)
- MD diameter: is the greatest mesiodistal dimension between the contact points of teeth on either side of jaw. (Fig. 2)

## Statistical Analysis

- Statistically significant sexual dimorphisms in male and female odontometric features were tested by the unpaired t-test.
- The differences in the mean values of the parameters between the right and the left side measured on study casts were tested using the paired t test.
- The mean values of MD and BL diameters of males and females were subjected to the formula to calculate sexual dimorphism.

$$\text{Sexual dimorphism} = X_m - 1 \times 100 \div X_f$$

Where  $X_m$  = mean value for males and  $X_f$  = mean value for females.

## Results

- About 39% of Udaipur population showed the presence of cusp of Carabelli, with males having slight higher percentage (40%) than females (38%).(Table 1)
- The MD and BL diameters were higher in males than females.(Table 2)
- MD diameter showed statistically significant sexual dimorphism.(Table 2)

## Discussion

Sex determination is one of the prime factors employed to assist with the identification of an individual. The accuracy of sex determination using diverse parameters of the body such as craniofacial morphology and measurements on the pubis ranges from 96% to 100%.<sup>[2,3]</sup> Correct sex identification limits the pool of missing persons to just one half of the population.<sup>[7]</sup>

The teeth are one of the strongest human tissues and are known to resist a variety of ante-mortem and post-mortem insults. The human dentition has a complement of 32 teeth; at least a few teeth may be recovered. Most teeth complete development before skeletal maturation and this makes dentition a valuable sex indicator, particularly in young individuals. Differences in dimensions can be due to greater dentine thickness in males, as the Y chromosome increases the mitotic potential of the tooth germ and induces dentinogenesis; whilst the X chromosome induces amelogenesis.<sup>[5]</sup>

Cusp of Carabelli is a nonfunctioning mini cusp that occurs on the Mesiopalatal cusp in permanent maxillary first molar. This cusp was first described by GEORGE CARABELLI in 1842. It is separated from mesiopalatal cusp by a groove which is also named as Cusp of Carabelli groove. It is a heritable Feature. Homozygosity of a gene is responsible for a pronounced tubercle while heterozygote show as slight grooves, pits, tubercles or

bulge. Its frequency appears to be higher in males than females.<sup>[6,7]</sup> It differ among races and species and can constantly alter due to natural selection and genetic changes.

In the present study, about 39% of Udaipur population showed the presence of cusp of Carabelli, with males having slight higher percentage (40%) than females (38%). On review of literature a higher percentage of cusp of Carabelli was observed in European countries, moderate percentage in South East, Middle East and other Asian countries with least percentage being observed in African countries (Table 3).

As well as in the present study the MD and BL diameters were greater in males than females. These findings were in accordance with studies conducted by various authors (Table 4) which revealed that the MD and BL dimensions in males were greater than females.

While on statistical evaluation MD diameters revealed significant sexual dimorphism than BL diameters. This finding was in contrast with studies conducted by Rai B et al,<sup>[15]</sup> Prathibha RM Rani et al,<sup>[17]</sup> Agnihotri G et al,<sup>[18]</sup> Sonika V et al<sup>[5]</sup> and Narang SR et al<sup>[19]</sup> which revealed BL dimensions demonstrating higher sexual dimorphism than MD. The variations observed among the different populations can be attributed to genetic, environmental, geographical and nutrition or dietary factors as they are known to affect tooth size.<sup>[20]</sup>

## Conclusion

India relies a lot on inexpensive and easy means of identification of persons from fragmented jaws and dental remains. The present study revealed 39% presence of cusp of Carabelli in Udaipur population and established the existence of statistically significant sexual dimorphism in maxillary first molars. Hence evaluation of cusp of Carabelli and measuring of MD and BL diameters is simple and inexpensive to conduct and therefore can be

applied in forensic odontology for establishing sex identity of an individual.

**Acknowledgments:** We would like to thank all the faculty members in the department of oral and maxillofacial pathology for their general support.

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**Legends Tables**

Table 1: Sexual Dimorphism With Respect To Cusp Of Carabelli

	Absent	Present	Percentage	Pearson-Chi Square	Df	Significance
Male	60	40	40%	33.68	1	.001
Female	62	38	38%	33.68	1	.001
Total	122	78	39%			

Table 2: Comparison of Mesio-Distal and Buccal-Lingual Diameters for Sexual Dimorphism in Males and Females

Parameters	Sex	Mean ± Sd	P Value
MD-R	M	9.73±0.91	0.001*
	F	9.20±0.67	
MD-L	M	9.69±0.82	0.001
	F	9.23±0.65	
BL-R	M	10.96±0.92	0.49*
	F	10.89±0.57	
BL-L	M	10.98±0.90	0.55*
	F	10.92±0.55	

\*indicates statistically significant difference at P≤0.05

Table 3: The Incidence of Cusp Of Carabelli In Various Regions Of World Is As Follows:

Author	Year	Conclusion
Alvesalo et al, Finland <sup>[8]</sup>	1975	79% of them had the cusp in first upper molars.
K. Mavrodisz et al, Hungary <sup>[9]</sup>	2007	The prevalence of Carabelli cusps was 65.34 % in the contemporary and 34 % in the 11 <sup>th</sup> century population.
M. Vodanovi et al, Croatia <sup>[10]</sup>	2013	Carabelli's trait is significantly greater (51.3%)
M Rusmah et al, Malaysia <sup>[11]</sup>	1992	52.2% showed presence of Carabelli's trait. Males have 65.1% and females 25.5%

Salah Al Shethri et al, KSA <sup>[7]</sup>	2011	57.6% of the Saudi population have a degree of expression of the Carabelli structure
Dila Baz Khan et al, Pakistan <sup>[6]</sup>	2011	29.7% of the study population in maxillary first permanent molar, Prevalence in males (31.9%) was slightly greater than females (25.9%).
Pradeep S et al, India <sup>[12]</sup>	2011	60% showed presence of cusp of Carabelli.
Dr. Rekhalkshmi et al, India <sup>[13]</sup>	2014	A total of 89.8% of primary second molars, 63.7% of permanent first molars, and 8% of permanent second molars showed some form of expression of Carabelli trait in the target population.
Olubode et al, Nigeria <sup>[14]</sup>	2002	17.43% showed presence of Cusp of Carabelli. Males have 18.81% while females have 16.28%.

Table 4: Studies conducted to demonstrate sexual dimorphism in various teeth

Author	Year	Conclusion
Rai B et al <sup>[15]</sup> Rohtak, Haryana	2007	Sexual dimorphism in maxillary first molar based on the criteria, when B-L diameter of either maxillary first molar is >10.7 mm, the probability of sex being male is 100%. <10.7 mm, the sex could be 82% female.
Rai B et al <sup>[16]</sup> Rohtak, Haryana	2008	Mandibular canine and maxillary first molar exhibit greater sexual dimorphism. M-D and B-L dimensions of maxillary and mandibular teeth were larger in males
Prathibha RM Rani, Karnataka <sup>[17]</sup>	2009	Males had greater B-L dimensions when compared to females, with moderate magnitude of dimorphism with accuracy rate of 78% in maxillary teeth.
Agnihotri G <sup>[18]</sup>	2010	Higher percentage for B-L dimension in maxillary first molar and also reported that hypocone exhibited greater dimorphism compared to other cusps.
Sonika V, Haryana <sup>[5]</sup>	2011	B-L dimension of right and left maxillary first molar exhibited greater sexual dimorphism among the intra-oral group and the study cast group, respectively. Males had larger dimensions of teeth than females.
Narang SR et al, Punjab <sup>[19]</sup>	2012	B-L dimension of maxillary first molar determined the sexual dimorphism among Punjabis.
Eboh et al, Nigeria <sup>[20]</sup>	2012	All the dimensions of maxillary first molars exhibited sexual dimorphism with males having larger dimensions than females.
Payal Sharma et al <sup>[21]</sup> Ghaziabad, Uttar Pradesh	2013	Male teeth were larger in dimensions than females The highest sexual dimorphism was shown by protocone in the maxillary first molar, sex determination accuracy was highest when the first molar was taken alone than when the second molar or the first and second molars were taken together.