



Observations of Odontogenic Traits: Carabelli's cusp, Number of cusps and Hypocone Variations in Molars

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Abstract

Dental Anthropology is a much newer sub field in anthropology, as compared to other subfields, but highly captivating and significant arena. The study of teeth has helped us a lot in excavating our past, present and future through micro evolutionary changes. The current study focuses on three such aspects of tooth that have evolved through time, since ages- namely the carabelli cusp, number of cusps present on molar teeth and the hypocone. The "Cusp of Carabelli" (COC) is a non-functioning, accessory cusp positioned on the mesio-palatal surface of permanent maxillary molars, predominately first molars and primary second molars. This supplemental cusp has been studied for several hundred years regarding size ranges, ethnic and racial distributions and genetic and/or environmental etiologies (Owens, et.al, 2016). The hypocone, a cusp added to the primitively triangular upper molar teeth of therian mammals, has evolved convergently > 20 times among mammals during the Cenozoic. Acquisition of the hypocone itself involves little phenotypic change, but subsequent diversification of groups possessing the hypocone may be greatly enhanced (Hunter, Jernvall, 1995).

The present study, is an empirical one, focusing on two caste groups of District Lucknow, India- Brahmin and Rajput females. A total of 600 samples were studied for the above-mentioned traits on maxilla and mandible through dental casts. The result shows significant differences amongst the two groups, with chi square test.

Key Words: - Dental anthropology, Molars, Carabelli's cusp, Number of Cusp on molars, Hypocone.

Prologue

Since ages teeth have played an important role in understanding prehistory and their course of evolution, in the study of fossils. It is so because teeth are the hardest part of the body and most of the times do not disintegrate even after millions and millions of years, if fossilized in appropriate environmental conditions. Study of teeth is referred to as Odontology, is most fascinating and interesting in population variation and racial classification, and have a long story to tell. The subject matter of teeth that comes under the sub field of physical anthropology is called dental anthropology.

The sobriquets Brahmin and Rajput are applied to numerous endogamous groups of older hierarchy times to two upper hierarchical castes, further divided into several sub castes. These two castes have great deal of morphogenetical, environmental and cultural diversities i.e., there are differences in their health, hygiene, nutritional habits, economic and cultural factors including the behavioural norms and practices relating to food and diseases etc. Perhaps these differences may form the basis for the observed morphological variations among the two castes, as these populations are interplay of many factors-biological, odontological anthropological social-cultural demography etc.

Aim of the Study

India, is a land of vast number of cultures and heritages, which includes people from various religions, linguistic, ethnic, creeds, having numerous customs and traditions, but mostly endogamous in nature. The populations are distinguished as tribal and non-tribal. Among the Hindus there are caste and sub castes, divided on dual system of philosophical and economic basis (Karve,1958-1959). Numerous physical anthropological studies on Indian populations particularly the Hindu castes have revealed immense morphological and genetical variability (Malhotra, 1974). As such the scientific study of caste has gained a new impetus, with the sole objective of understanding not only the extent of variability but also the reason for such tremendous variety and determine the degree of relatedness. It is also likely to reveal the circumstances responsible for the biocultural diversity and adaptation in current situation.

Methodology

The study under consideration emphasizes on two large female endogamous groups of Mendelian nature of district Lucknow- the Brahmin and the Rajput. The data was collected from different areas of Lucknow-educational institutes and households. The subjects were randomly selected from 6-25 years of age. A total of 600 samples were collected altogether (300 Brahmin females & 300 Rajput females). Three traits were studied through dental casts, taken from the subjects. Any discrepancies in dental arcade or teeth were not considered.

The traits studied among the two populations understudy include Carabelli's trait, hypocone variation of maxillary molars and number of cusps on each molar tooth. All these non- metric traits

have been subjected to chi- square test, and the extent of variability or reflection of similarities in between the two caste groups is based on the above test. Apart from this, present study was also compared with other populations of India for Carabelli's trait, as the data was available for this only.



Figure 1: - An accessory cusp on the maxillary molars (Carabelli cusp).

Results

Carabelli Trait/ Tuberculum Anomale

is named after its discoverer Von Carabelli in 1842, is an additional cusp that develops as an elevation or tubercle on the lingual surface of the mesio-lingual cusp (protocone) of the deciduous and permanent maxillary first molars in the mesiopalatal line. It is a highly primitive character because its occurrence has been reported in the living lower primates also (Frisch 1963). However, it has also been reported in evolutionary tree of fossil Australopithecines & Mousterian man. Evidently this is an evolutionary change towards simplification of the first molar at least in some human populations. This cusp is heritable and such micro-evolutionary modifications are a consequence of the combined effect of genes and ecological factors. Since population both extinct and living have always lived in different environments and their genotypes have depended on their population size and mating pattern, such variations are understandable, notwithstanding the evolutionary changes towards simplification of the dental morphology (Singh, 2005). Kraus (1951) proposed that homozygosity of a gene is responsible for a pronounced tubercle, whereas the heterozygote shows slight grooves, pits, tubercles or bulge. Later studies showed that the development of this trait is affected by multiple genes. The cusp of Carabelli is most common among Europeans (75-85% of individuals) and rarest in Pacific Islands (35-45%).

Table No.- 1

Percentile Occurrence of Carabelli's Trait (1st Maxillary Permanent Molars)

Population	Sample size	Right Side(R)	Left Side (L)	Mean (R+L/2)	Standard Error (SE)	Standard Deviation (SD)	SE of SD
Rajput	300	15.66	13.0	14.33	.014	.17	.012
Brahmin	300	24.0	20.33	22.16	.014	.17	.010

right $\chi^2 > .01 = 6.538$

left $\chi^2 > .01 = 5.808$

Table no. 1, shows that the presence of carabelli's trait is more amongst the Brahmin females, as compared to Rajput, and the difference is very much significant. 15.66 percent of the Rajput females and 24.0 percent of the Brahmins show the presence of carabelli's cusp on the 1st permanent **right** maxillary molar, while 13.0 percent of the Rajput and 20.33 per cent of the Brahmin females show its occurrence on the **left side**. Thus, the mean value for the Rajput females falls at $14.33 \pm .014$, with the standard deviation of $.17 \pm .012$. The mean value exhibited by the Brahmin females is $22.16 \pm .014$, and $SD = .17 \pm .010$.

The mean value of the two groups shows considerable difference, even highlighted by the chi-square test. $\chi^2 > .01$, with values of $\chi^2 = 6.538$ for right and 5.808 for the left maxillary molars. Degree of freedom is equal to 1.

Hypocone Variation: - There are large numbers of morphological variations known in the molars unlike in other teeth groups. Variations in the number of cusps of maxillary first, second and third molars of modern man attracted the attention of physical anthropologists.

A cusp in general is an elevated, projected and pointed feature, present on the crown of molars. The hypocone or distolingual cusp, a cusp added to the primitively triangular upper molar teeth of therian mammals. It is most variable cusp of evolutionary significance in the maxillary molars, which is sometimes absent and when present varies in size. It is thus, the key innovation in mammalian evolution. It is the most independently evolved feature among

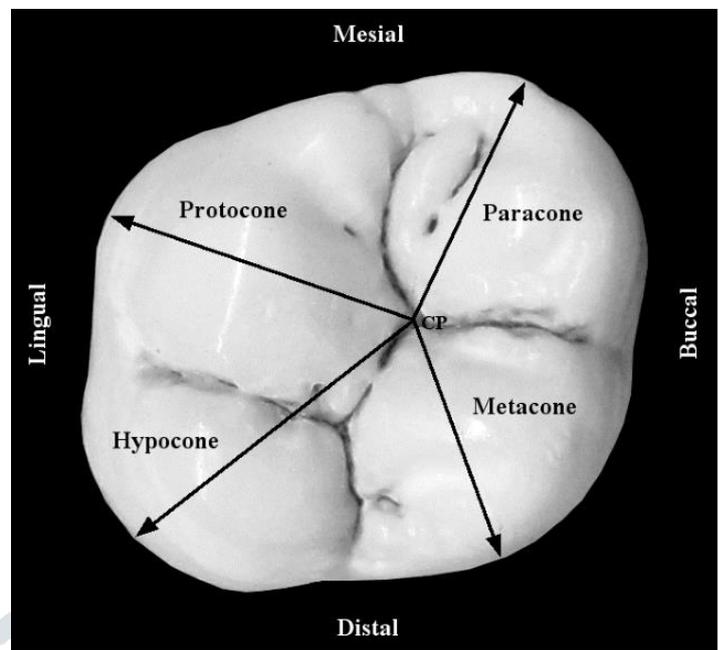


Figure 2: primary cusps on maxillary first molars. Source: - Fatima EL, et al (2016).

mammalian lineage, (almost twenty times) during evolution in Cenozoic era, that leads to varied diversities in higher taxas. The usual number of maxillary molar cusps ranges from three to four.

Dahlberg's 1963 classification for the variation in the size of hypocone is as follows,

- 4 = all the four cusps present in well-developed form
- 4- = the distolingual cusp slightly reduced in size.
- 3+ = the distolingual cusp reduced in size to smaller capsule
- 3 = three main cusps present and the distolingual completely absent.

Table No. 2

Hypocone Variation of the Maxillary Molars

Population	No. of Individual	M1			M2			No. of Individual	M3		
		4	3	3+	4	3	3+		4	3	3+
Rajput	300	97.66	2.34	-	44.33	20.66	32.66	135	4.22	22.64	-
Brahmin	300	99.0	0.0	1.0	60.8	2.01	32.56	135	3.05	28.78	-

d.f. = 2 $\chi^2 < .10 = 3.349$ $\chi^2 > .001 = 18.861$ $\chi^2 < .30 = .5089$

The percentage frequency for hypocone variation portrayed in table no. 2, for the two female populations under study. **Hypocone variation of the maxillary 1st molars is negligible**, whereas in case of 2nd molars the variation for the trait is greatest. Amongst the Rajput females the presence of 4 cusps is observed in 97.66 per cent of them, but for the Brahmins the percentage is slightly higher (99.0 per cent). 2.34 per cent of the Rajput females have 3 cusps, whereas in case of Brahmin only 1 per cent of the females exhibit 3 cusps in their maxillary first molars.

2nd Molars: - 44.33 per cent of the Rajput females have 4 cusps, 20.66 per cent show 3 cusps and 32.66 per cent of them have only 3+ cusps in their maxillary 2nd molars. While 60.43 per cent of the Brahmin females have 4 cusps, 2.01 per cent have 3 cusps and 32.56 per cent of them have 3+ cusps. In 5.2 per cent Brahmins and 2.8 per cent Rajput females, the permanent 2nd Molar's eruption was awaited on both the sides.

3rd Molars: For third molars only 135 individuals each were examined for the two caste groups. Only 4.22 per cent of the Rajput and 3.05 per cent of the Brahmin show 4 cusps for this molar, while 22.64 per cent of the Rajput females and 28.76 per cent of the Brahmin have 3 cusps in their third molars. The difference for 3 cusps is slightly significant. In rest of the subjects, 3rd molar erupted in degenerated forms.

The chi-square test reveals not much difference for the 1st Molars between the two groups, as the $\chi^2 < .10 = 3.349$, for 2nd molar, the differences are most significant and $\chi^2 > .001 = 18.851$, while for the 3rd molar overall differences are insignificant, $\chi^2 < .30 = .5089$, but for the presence of 3 cusp, the differences are significant. The value for degree of freedom is equal to 2.

Cusp Numbers of Mandibular Molars: -The morphological variations of the mandibular molars are best studied from the angle of their occlusal surface patterns and cusp numbers. Hellman 1928 stated that groove patterns and cusp numbers are interdependent. Though cusp numbers and groove pattern for individual molars are described as Y⁵, Y⁵, +4, +3 and so on, it has been shown by Garn et al 1966, that these two features are independent of each other. Cusp number shows the common occurrence of 5 cusps in first and third molars and 4 cusps in second molars of the majority of populations, the exceptions being Mesolithic Sudanese, Jomonese, Neolithic people of Nagarjunakonda and Harappans of Mohenjo-Daro for 1st molars, Bushmen, Alaskan Eskimos, Peruvian Indians and Jomonese for second molars; Mesolithic Sudanese, ancient Egyptian, Whites and New Guinean females in respect of third molars. (Reddy, 1985).

Table No. 3
Percentile Occurrence of Cusp Number of Mandibular Molars

Population	No. of Individual	M1			M2			No. of Individual	M3		
		6	5	4	6	5	4		6	5	4
Rajput	300	4.33	70.66	25.0	-	15.5	84.5	135	-	-	40.0
Brahmins	300	1.68	67.66	30.66	-	4.5	95.5	135	-	-	37.8

$\chi^2 < .30 = 11.3118$, d.f.= 2

This trait has been represented in table no. 3. It is exhibited that among the Rajput females the occurrence of 5 cusps in 1st Molars is 70.66, 4.33 percent individuals have 6 cusps and 25 per cent have 4 cusps. Similarly, for 1st Molars, 67.66 percent Brahmin show 5 cusps, 1.68 percent 6 cusps and 30.66 per cent of them have 4 cusps in their 1st mandibular molars.

Second Molars: - Rajput females show common occurrence of 4 cusp (84.5 percent) and 15.5 per cent have 5 cusps in their second molars, 6 cusps are not noticed amongst them for 2nd molars. Whereas, for the Brahmins, the values are - it is 95.5 percent have 4 cusps and 4.5 percent have 5 cusps. Here also 6 cusps are not noticed amongst them for 2nd molars.

Third Molars: - For this molar only 135 individuals each per group have been observed, as third molars start erupting from 17 years of age. 40.0 percent of the Rajput show the presence of 4 cusps. While in case of Brahmin females 4 cusps occur in only 37.7 per cent of the individuals. The chi-square test reveals no significant difference

in the cusp numbers for the three concerned molars of the two groups under study. The $\chi^2 < .30$ having a value of 11.3118. Degree of freedom is equal to 2.

Discussion & Conclusion

In order to understand the exact standing of the Rajput and Brahmin females with some other counterpart population, an attempt has been made to compare the data only with those populations on whom relevant data were available. The few dento-morphological reports currently available suffer several significant limitations i.e., the data mainly comprises of males or is of mixed type, but the data on females is very scarce. The above naturally imposes limitations on the comparative evaluation of the present study, as it is based on females only. The two group of females- Brahmin and Rajput, understudy clearly exhibit significant differences for Carabelli's cusps, number of cusps on 2nd mandibular molars and 2nd molar hypocone variations. Table no.4 & 5 show cases a comparative data of the two female groups of the present study with that of other populations of India.

Table No.-4

The Chi- Square Values for Carabelli's Trait in Various Populations, in comparison to Brahmins

Populations	χ^2 Value
Brahmins X Yadav	20.570
Brahmins X Pallis (A.P.)	0*
Brahmins X Muslims (A.P.)	.220**
Brahmin X Pattusalis	0.470**
Brahmin X Modern Bengali Skulls	1.020**

** = shows non-significant difference

The comparative study of tables no. 4 & 5, reveals that Brahmin, Rajput and other populations included here, the Brahmins of the present series stand **apart from the Yadavs of Andhra Pradesh** in context of carabelli's trait as χ^2 Value is **20.570**, which is quite significant. The Brahmin females of Lucknow are found to be closer to the Pallis, Muslims and the Pattusalis of Andhra Pradesh & Modern Bengali skulls, showing non-significant differences between themselves, having χ^2 Values of **.220, 0.470, and 1.020**.

Table No.-5

The Chi Square Test for Carabelli's Trait of Various Populations in comparison to Rajputs

Population	χ^2 Value
Rajput X Brahmin (Lko)	5.808
Rajput X Yadav (A.P.)	33.428
Rajput X Pallis (A.P.)	1.996**
Rajput X Muslims (A.P.)	3.609
Rajput X Pattusalis	.560**
Rajput X Modern Bengali Skulls	5.853

**= shows non-significant difference

The populations of the present study of Lucknow district also stand at a wide distance from each other, having χ^2 Value of 5.808. When compared with other populations, the Rajput females, show more variability with other compared populations than their Brahmin counterpart. The Rajput females show variations with Yadavs, Muslims of Andhra Pradesh and Modern Bengali skulls, χ^2 Values being 33.428, 3.609 and 5.853. The Rajput females show closeness with Pallis and Pattusalis of Andhra Pradesh, with non-significant χ^2 Value of 1.996 and .560 respectively.

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