BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 21, Issue 10

DOI:10.58240/1829006X-2025.21.10-219

ORIGINAL RESEARCH

NON METRIC DENTAL CROWN TRAITS IN A DISTINCT TRIBE OF SOUTH INDIA

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Received: *Sep.22, 2025;* ***Accepted:*** *Oct. 10, 2025;* ***Published:*** *Nov 4, 2025*

ABSTRACT

Background: Non-metric dental crown traits (NDCT) are an established ancillary means of race identification. Population specific NDCT need to be identified in ethnic groups as these may serve as adjuvant tools in population and individual identification. Scanty studies are found on the tribal population of India and on tribals of Kerala. Irula Tribals constitute a distinct ethnic population of Palakkad district in the state of Kerala, South India. The present cross-sectional descriptive study was done on 150 males and 150 females of this population to assess the frequency, distribution and sexual dimorphism of NDCT as an adjunct in population identification.

Materials and Methods: Intraoral maxillary and mandibular impressions were taken and casts were prepared. Twenty- six maxillary and thirteen mandibular NDCT were examined and recorded. The grade-wise frequency and variability of these traits were analysed using Chi-squared test with SPSS Version 25 (p-value < 0.05).

Results: High incidence of shovelling (72% of males and 62% of females) and cusp of Carabelli (44% in males and 39.3% in females) was observed. Grading for shovelling was between 1 and 3 in 59.4% of the population, and that for cusp of Carabelli was only 1 in 16%. Labial convexity showed low incidence as well as low grading. Sexual dimorphism was observed in six traits, of which three had fairly high incidence.

Conclusion: Shovelling and cusp of Carabelli may define the Irula population due to higher incidence and strong manifestation, while it may not be possible to consider labial convexity as a trait for this population. The studied population shows an affinity to Europeans based on the incidence of traits exhibiting distinct geographic variation. Further studies are recommended on non-metric traits in Irula as well as other tribal populations of India.

Keywords**:** Nonmetric dental traits, Irula tribe, South India, Dental morphology, Forensic dentistry

INTRODUCTION

Non-metric dental crown traits (NDCT) is the term to denote the numerous variations in dental morphology that occur in deciduous and permanent human dentitions[1]. They can be readily observed and recorded at low cost[2]. NDCT can be identified even in fossils[1] as enamel is resistant to extreme conditions of pH, dampness, salinity and increased heat[3]. They are reliable and can even serve as a proxy for genetic evaluation[4]. The frequency of expression of NDCT as well as the distribution of their grading characterize a population. Thus, the trait of one population may be an anomaly in another[2]**.** NDCT thus is a favoured tool in forensic dentistry and anthropology and is valuable in estimation of population affinities and determination of ancestry[5]. Population-specific NDCT need to be identified in ethnic groups as these may serve as adjuvant tools in population and individual identification. To the best of our knowledge, scanty studies have been done on the dental anatomy of the tribal population of India and specifically on tribals of Kerala.

The Irula are an indigenous tribal group who constitute a distinct ethnic population having their own heritage, language and lifestyle[6]. The present study was undertaken to estimate the frequency, distribution and sexual dimorphism of non-metric dental traits among Irula tribals of Palakkad district in the state of Kerala, South India. The results showed higher incidence shovelling, cusp of Carabelli and midline diastema compared to other traits. Sexual dimorphism was observed in Distal Accessory Ridge (DAR) of canines and upper first premolars.

MATERIALS AND METHODS

The present descriptive cross-sectional study

aimed to determine the frequency and grading of thirty-nine NDCT among Irula Tribals using the Arizona State University Dental Anthropological System (ASUDAS), to elicit gender specificity, if present, in these traits and discern any possible racial affinity as an adjunct in population identification. Of these traits, twenty-six were maxillary and thirteen were mandibular. (Table 1).

Table 1. List of NDCTs recorded in the present study

Table 1 List of NDCTs recorded in the present study			
S. No	MAXILLARY	S. No	MANDIBULAR
1.	Midline diastema (MLD)	1.	Cusp no of LP2
2.	Labial Convexity	2.	Hypoconulid on LM2 (Cusp 5 on LM2)
3.	Winging	3.	Distal Accessory Cusp (DAC) on LM1 (Sixth cusp)
4.	Shovelling	4.	Lingual Accessory Cusp (LAC) on LM1 (Seventh cusp)
5.	Double Shoveling	5.	Groove pattern of molars on LM2
6.	Interruption Grooves	6.	Molar cusp no on LM2
7.	Dental tubercle	7.	Deflecting wrinkle on LM1 (DW)
8.	Lateral incisor variants	8.	Anterior Fovea
9.	Mesial Canine Ridge / Bushman's Canine	9.	Distal Trigonid Crest (DTC)
10.	Distal Accessory Ridge of Canines (DAR of Canines)	10.	Mid-Trigonid Crest (MTC)
11.	Mesial Accessory Ridge of UP1 (MAR of UP1)	11.	Pegged/Reduced/Missing Third molars
12.	Distal Accessory Ridge of UP1 (DAR of UP1)	12.	Torsomolar angle
13.	Mesial Accessory Ridge of UP2 (MAR of UP2)	13.	Protostylid
14.	Distal Accessory Ridge of UP2 (DAR of UP2)		
15.	Mesial and Distal Accessory Cusps of Premolars		
16.	Premolar Odontomes		
17.	Uto-Aztecan upper premolar		
18.	Metacone reduction (DB reduction)		
19.	Hypocone reduction (DL reduction)		
20.	Bifurcated Hypocone		
21.	Metaconulo (Cusp5 between DB & DP)		
22.	Carabelli's trait		
23.	Marginal Ridge Protoconule		
24.	Marginal Ridge Mesial Accessory Tubercle		
25.	Marginal Ridge Mesial Paracone Tubercle		
26.	Parastyle		

The study was commenced after obtaining approval from the Institutional Research Committee (ACDS / 185 /2022), ethical clearance from the Institutional Ethics Committee (AEC/REV/2022/19) and permission from all relevant government authorities. The study population consisted of 300 subjects belonging to Irula Tribal population, 150 each from either gender. Subjects of age 18 to 40 years with intact teeth on at least one side of the jaws were selected from seven tribal hamlets of Attapady Taluk, Palakkad district of Kerala by purposive sampling over a period of three months. Those having soft or hard tissue palatal abnormalities, generalised attrition, rampant caries, multiple missing or fractured teeth or who have undergone any form of intraoral surgery or orthodontic treatment were excluded from the study. Informed consent was taken after confirming through the Tribal promoter of the concerned hamlet that they were members of the Irula tribal population belonging to Attapady Taluk with no known history of migration from other regions. Intraoral maxillary and mandibular impressions of the selected subjects were taken using dust-free alginate loaded into perforated dentulous metal trays. The impressions were promptly poured with Type III dental stone to form detailed dental casts. The NDCT were determined by visual examination of dental casts. Sixteen casts, which were distorted due to faults in fabrication and which had bubbles, were discarded. The sampling process was repeated, and sixteen new casts were prepared to replace the discarded casts. The 150 male and 150 female casts were examined under broad daylight using a 10x hand magnifying lens[6] by a single observer. Short breaks of 5 minutes were taken after examination of one upper and one lower cast to avoid eye fatigue. The key teeth were examined for the respective traits, and if present on both sides of the arch, the higher grade was recorded. If the key tooth was missing or distorted on one side, the corresponding tooth on the opposite side was scored. Each cast was examined twice to ensure consistency and reduce potential observer error. If different values were obtained, it was examined once more, and the value obtained twice was recorded. The data was entered in an excel worksheet[7]. The study conforms to STROBE guidelines.

Statistical Analysis

The percentage of the traits and their grades of expression in the population were calculated. The mean frequencies of the traits in the two groups, male and female, were compared pairwise using Chi-squared test with Statistical Package for Social Science Version 25. A p-value of <0.05 was considered statistically significant. The population affinity to the major world populations was assessed using the frequency of those traits which exhibit distinct geographical variation and their grades.

RESULTS

There was a total of 300 participants in the study. Of these, 150 were males and 150 were females. The frequency of occurrence and the percentage of each grade of the thirty-nine NDCT in the total study population were tabulated. There was high incidence in shovelling, being present in 72% of males and 62% of females. Of these, the total percentage of frequency of grades 1 to 3 of shovelling was 59.4% while grades 4 to 7 combined were expressed in only 7.7%. This indicated greater expression of lower grades in shovelling. There was also a notable incidence of Carabelli's cusp, with an incidence of 44% in males and 39.3% in females, of which grade 1 was seen in 16% and grades 2 to 7 combined were expressed in 25.7%. Labial convexity showed low incidence as well as grading. This trait was absent (grade 0) in 49.3% of males and 40% of females, with the incisors exhibiting a flat surface. Of the subjects in which this trait was present, 34.7% of males and 42% of females showed only grade 1 convexity. (Table 2)

Table 2. Frequency Distribution and Percentage of Grade Expression in the total study population

S.No	Trait	Grade	Frequency of occurrence	%
1.	Mx Midline diastema	0	242	80.7
		1	58	19.3
2.	Mx Labial Convexity	0	134	44.7
		1	116	38.7
		2	40	13.3
		3	10	3.3
3.	Mx Winging	1A	1	0.3
		3	275	91.7
		1B	10	3.3
4.	Mx Shoveling	0	99	33
		1	90	30

		2	65	21.7
		3	23	7.7
		4	9	3
		5	6	2
		6	8	2.7
5.	Mx Double Shoveling	0	298	99.3
		1	1	0.3
		2	1	0.3
6.	Mx Interruption Grooves	0	300	100
7.	Mx Dental tubercle	0	295	98.3
		1	1	0.3
		2	1	0.3
		3	1	0.3
		5	2	0.7
8.	Mx lat incisor variants	0	298	99.3
		1	2	0.7
9.	Mx Mesial Canine Ridge / Bushman's Canine	0	300	100
10	Mx Distal Accessory Ridge of Canines	0	260	86.7
		1	23	7.7
		2	16	5.3
		3	1	0.3
11	Mx Mesial accessory ridge of UP1	0	292	97.3
		1	2	0.7
		2	4	1.3
		3	2	0.7
12	Mx Distal accessory ridge of UP1	0	289	96.3
		1	3	1
		2	3	1
		3	5	1.7
13	Mx Mesial accessory ridge of UP2	0	284	94.7
		1	4	1.3
		2	4	1.3
		3	8	2.7
14	Mx Distal accessory ridge of UP2	0	280	93.3
		1	1	0.3
		2	17	5.7
		3	2	0.7
15	Mx Mesial and Distal Accessory Cusps	0	300	100

16	Mx Premolar Odontomes	0	300	100
17	Mx Uto-Aztecan upper premolar	0	300	100
18	Mx Metacone (DB) reduction	2	3	1
		3	39	13
		3.5	145	48.3
		4	92	30.3
		5	22	7.3
19	Mx Hypocone (DL) reduction	0	50	16.7
		1	6	2
		2	30	10
		3	128	42.7
		3.5	68	22.7
		4	18	6
20	Mx Bifurcated Hypocone	0	290	96.7
		1	10	3.3
21	Mx Metaconulo (Cusp5 btw DB-DP)	1	262	87.6
		2	12	4
		3	17	5.7
		4	8	2.7
22	Mx Carabelli's trait	0	175	58.3
		1	48	16
		2	8	2.7
		3	31	10.3
		4	10	3.3
		5	18	6
		6	8	2.7
		7	2	0.7
23	Mx Marginal Ridge Protoconule	0	292	97.3
		1	8	2.7
24	Mx Marginal Ridge Mesial Accessory Tubercle	0	296	98.7
		1	4	1.3
25	Mx Marginal Ridge Tubercles Mesial Paracone Tubercle	0	290	96.7
		1	10	3.3
26	Mx Parastyle (Cusp buccal surface)	0	299	99.7
		2	1	0.3

27	Cusp no of LP2	0	54	18
		2	132	44
		3	49	16.3
		4	65	21.7
28	Cusp 5/Hypoconulid on LM2	0	227	75.7
		1	14	4.6
		2	33	11
		3	20	6.7
		4	5	1.7
		5	1	0.3
29	Mn Sixth cusp (DAC) on LM1	0	283	94.3
		1	10	3.3
		2	6	2
		3	1	0.3
30	Mn Seventh cusp (LAC) on LM1	0	289	96.7
		1	2	0.7
		2	6	2
		3	2	0.7
31	Mn Groove pattern of molars on LM2	1	199	66.3
		2	48	16
		3	53	17.7
32	Mn molar cusp no on LM2	0	1	0.3
		1	1	0.3
		3	1	0.3
		4	228	76
		5	69	23
33	Mn Deflecting wrinkle on LM1	0	1	0.3
		1	230	76.7
		2	30	10
		3	29	9.7
		4	10	3.3
34	Mn Anterior Fovea	0	283	94.3
		1	15	5
		2	2	0.7
35	Mn Distal Trigonid Crest	0	300	100
36	Mn Mid-Trigonid Crest	0	300	100
37	Mn Pegged/Reduced/Missing Third molars	0	243	81
		1	4	1.3

		3	53	17.7
38	Mn Protostylid (Cusp buccal surface)	0	300	100
39	Mn Torsomolar angle	0	288	96
		1	12	4

Midline Diastema (MLD) was seen in 26.7% of males, which is a fairly high occurrence, and in 12% of females. DAR of canines is seen in 18.7% of males and only 8% of females. Metacone (DB cusp) reduction in the second upper molar UM2 was present in 87.3% of males and 98% of females, of which the intermediate-sized cusp (grade 3.5) appeared in the largest frequency in both sexes. Eighteen maxillary and seven mandibular traits had a frequency of < / = 10%. (Table 2)

The frequency of occurrence of NDCT and their percentage were dichotomised based on presence and absence in the 150 males and 150 females of the study population. The DAR of premolars is found to occur in higher frequency than the MAR in both males and females, except in the first upper premolar (UP1) of males, where MAR shows more occurrence. Of the 300 samples examined, bifurcated hypocone was observed only in one male. Statistically significant sexual dimorphism was noted in the six traits, namely, MLD, DAR of canines, Metacone reduction in UM2 (grades 2,3,3.5 & 4), MAR and DAR of second upper premolar (UP2), bifurcated hypocone and anterior fovea. The sexual dimorphism cannot be considered valid in MAR and DAR of UP2, bifurcated hypocone and anterior fovea, as these traits showed an incidence of less than 10%. Anterior fovea was found to occur with grades 1 and 2 only. (Table 3).

Table 3. Sexual Dimorphism in NDCT with P-Value

TRAIT	Dichotomy	FEMALE		MALE		p-value
		Frequency of occurrence	%	Frequency of occurrence	%	
Mx Midline diastema	ABSENT	132	88	110	73.3	0.001
	PRESENT	18	12	40	26.7	
Mx Labial Convexity	ABSENT	60	40	74	49.3	0.131
	PRESENT	90	60	76	50.7	
Mx Winging	ABSENT	135	90	140	0.93	0.296
	PRESENT	15	10	10	6.7	
Mx Shoveling	ABSENT	57	38	42	28	0.085
	PRESENT	93	62	108	72	
Mx Double Shoveling	ABSENT	150	100	148	98.7	0.498
	PRESENT	0	0	2	1.3	
Mx Interruption Grooves	ABSENT	150	100	150	100	
Mx Dental tubercle	ABSENT	149	99.3	146	97.3	0.367
	PRESENT	1	0.7	4	2.7	
Mx lat incisor variants	ABSENT	150	100	148	98.7	0.478
	PRESENT	0	0	2	1.3	
Mx Mesial Canine Ridge / Bushman's Canine	ABSENT	0	0	0	0	
	PRESENT	150	100	150	100	

Mx Distal Accessory Ridge of Canines	ABSENT	138	92	122	81.3	0.011
	PRESENT	12	8	28	18.7	
Mx Mesial accessory ridge of UP1	ABSENT	148	98.7	144	96	0.282
	PRESENT	2	1.3	6	4	
Mx Distal accessory ridge of UP1	ABSENT	143	95.3	146	97.3	0.539
	PRESENT	7	4.7	4	2.7	
Mx Mesial accessory ridge of UP2	ABSENT	148	98.7	136	90.7	0.005
	PRESENT	2	1.3	14	9.3	
Mx Distal accessory ridge of UP2	ABSENT	145	96.7	135	90	0.037
	PRESENT	5	3.3	15	10	
Mx Mesial and Distal Accessory Cusps	ABSENT	150	100	150	100	
Mx Premolar Odontomes	ABSENT	150	100	150	100	
Mx Uto-Aztecan upper premolar	ABSENT	150	100	150	100	
Mx Metacone (DB) reduction	ABSENT	3	2	19	12.7	0.001
	PRESENT	147	98	131	87.3	
Mx Hypocone (DL) reduction	ABSENT	0	0	0	0	-
	PRESENT	150	100	150	0	
Mx Bifurcated Hypocone	ABSENT	150	100	140	93.3	
	PRESENT	0	0	10	6.7	
Mx Metaconulo (Cusp5 btw DB-DP) (Absent-Grade1)	ABSENT	133	88.7	129	86	0.487
	PRESENT	17	11.3	21	14	
Mx Carabelli's trait	ABSENT	91	60.7	84	56	0.482
	PRESENT	59	39.3	66	44	
Mx Marginal Ridge Protoconule	ABSENT	148	98.7	144	96	0.282
	PRESENT	2	1.3	6	4	
Mx Marginal Ridge Mesial Accessory Tubercle	ABSENT	148	98.7	148	98.7	1
	PRESENT	2	1.3	2	1.3	
Mx Marginal Ridge	ABSENT	148	98.7	142	94.7	0.108

Tubercles Mesial Paracone Tubercle	PRESENT	2	1.3	8	5.3	
Mx Parastyle (Cusp buccal surface)	ABSENT	150	100	149	99.3	0.317
	PRESENT	0	0	1	0.7	
Cusp no of LP2 (Absent-Grade 0)	ABSENT	0	0	0	0	-
	PRESENT	150	100	150	100	
Cusp 5/Hypoconulid on LM2	ABSENT	117	78	110	73.3	0.346
	PRESENT	33	22	40	26.7	
Mn Sixth cusp (DAC) on LM1	ABSENT	142	94.7	141	94	0.803
	PRESENT	8	5.3	9	6	
Mn Seventh cusp (LAC) on LM1	ABSENT	146	97.3	143	95.3	0.357
	PRESENT	4	2.7	7	4.7	
Mn Groove pattern of molars on LM2 (Absent-NIL)	PRESENT	150	100	150	100	
Mn molar cusp no on LM2 (Absent-NIL)	ABSENT	0	0	0	0	0.317
	PRESENT	150	100	150	100	
Mn Deflecting wrinkle on LM1 (Absent-1)	ABSENT	115	76.7	115	76.7	1
	PRESENT	35	23.3	35	23.3	
Mn Anterior Fovea	ABSENT	146	97.3	137	91.3	0.046
	PRESENT	4	2.7	13	8.7	
Mn Distal Trigonid Crest	ABSENT	150	100	150	100	
Mn Mid-Trigonid Crest	ABSENT	150	100	150	100	
Mn Pegged/Reduced/Missing Third molars	ABSENT	119	79.3	124	82.7	0.556
	PRESENT	31	20.7	26	17.3	
Mn Protostylid (Cusp buccal surface)	ABSENT	150	100	150	100	
Mn Torsomolar angle	ABSENT	145	96.7	141	94	0.412
	PRESENT	5	3.3	9	6	

The traits with established geographical variation were compared (Table 4) and probable population affinities were tabulated (Table 5) with documented data cited by Tinoco RL et al [8].

Table 4. Comparison between the frequencies found in this study and those in the study by Irish and Hanihara

NDCT (Grade)	Data from present study (%)	Data from Irish et al (%)[1]		Data from Hanihara et al. (%)[1]	
	Irula Tribals of Palakkad, Kerala	Sub-Saharan	European	Sub-Saharan	European
Shovelling	67	5.3	2.6	50.9	33.3
Cusp of Carabelli	41.7	16.4	24	17.1	22.7
3-cusped UM2	16.7	9.7	22.3	9.7	24.3
4-cusped LM2	76	24.1	77	67.7	24.7
Cusp 6 on LM1	5.7	16.6	11.5	22.1	5.9

Table 5. Probable Population Affiliation

NDCT	Total Incidence	%	Population	
			Least likely affiliation	Most likely affiliation
Shovelling (Grade 0)	99	33	Sino-American	European, African
Shovelling (Grade 4-7)	23	7.7	Sino-American	European, African
Carabelli's cusp (Grade 5-7)	28	9.4	All other	Native American
Cusp 5 (Grade 2-7)	59	19.7	Australian, African	European, Sino-American
4-cusped LM1 and/or LM2 (grade 4)	228	76	All other	European
Cusp 6 (grades 1 - 5)	17	5.6	All other	European

DISCUSSION

The present study was carried out to document the prevalence of selected NDCT in the Irula tribal population of Palakkad district, Kerala and determine sexual dimorphism in these traits. The need for recording NDCT specific to an area, gender and ethnicity has been emphasised by many researchers[7]. India has a diverse population consisting of different ethnicities and origins. However, NDCT distribution is unknown in several population groups. This study attempts to bridge the gap by providing data regarding NDCT in the selected tribal group. A definite correlation is found to exist between NDCT and the region of study[3]. This selected tribal group is confined to a definite geographical area, and hence this study can contribute greatly in defining this population.

We have exclusively made use of ASUDAS, which is an acknowledged standard reference tool for identifying NDCT due to its reliability and effectiveness in recording. Our study population is an ancient indigenous group of South India, socio-culturally segregated from the non-tribal population. Hence, traits specific to this group are expected to be present. The most effective results are obtained when only such traits are examined rather than the whole ASUDAS set. The identification of a greater number of such variants may provide more reliable inference of genetic affinities[5]. However, there are no previous studies on NDCT in this population available in the literature. This has necessitated the inclusion of all ASUDAS NDCT in this study.

The incidence of both shovelling and cusp of Carabelli are found increased in our study. The findings may be attributed to the genetic pool of the Irula population as genetics plays an important role in the development of NDCT. The role of genetics has been extensively investigated by comparing NDCT with neutral genomic markers on continental and global levels[4]. An example is the discovery of inter tribe genetic affinity among the Eastern Slavic tribes[9]. The frequency of dental traits in a Latin American study reflects their admixed Native American, European and African genetic ancestry[10]. Also, in a study on the influence of the pre-Hispanic population of Northern Andes, a notable finding was that the Early Holocene samples did not show Sinodont characteristics[11]. It is proven that race could be determined with the help of dental morphological traits, and individuals could be assigned to any one of the five ancestral categories: Western Eurasian, Sub-Saharan African, Sino-American, Sunda-Pacific, or Australo-Melanesian. This is done by considering each individual as a group in which the individual dichotomous values were substituted by the highest or lowest global frequencies[12].

The results inferred from genetic and non-metric trait distance matrices show that populations within an ethnic group showed the closest affinity, while samples from different ethnic groups showed increased divergence[13]. Irula, being a distinct ethnic group the frequency and distribution of their NDCT may reveal their racial affinity.

A study using DNA markers done on five Dravidian-speaking tribal populations hailing from the Nilgiri Hills of Tamil Nadu exhibited close relation among the Indian population. It was revealed that these groups do not show any genetic affinity to Africans despite the similarity of the phenotypic characteristics to the latter. The authors attribute this disparateness to convergence[14]. Our study supports this finding as the traits observed in the Irula, a similar tribal group, are also not Negroid.

There is a distinct polarisation of traits noted between the Eastern and Western population as observed by Dahlberg way back in 1951, Hanihara in 1968 and Zuobov in 1973. Shovelling increased in frequency or maintained the level of prevalence in the East, while it was found to decrease in the West at a steady rate. The cusp of Carabelli, on the other hand, is a well-documented Caucasoid trait[15].

The incidence of the cusp of Carabelli found in our study is akin to the findings by both Irish and Hanihara et al in Europeans. The frequency of the cusp of Carabelli in Europeans (Caucasoids) is 22.7% and that of shovelling is 33.3% in a study by Hanihara[8]. The frequency of the cusp of Carabelli in Europeans as recorded by Irish et al is 24% and that for shovelling is 2.6%. Low incidence of Carabelli's cusp (17.78%) was seen in a study on the Kerala population, and this is supported by previous Indian studies. The authors state that the cusp of Carabelli is not an Asian trait, mentioning earlier studies[16]. The increased incidence of the cusp of Carabelli in our study, hence raises queries on assigning an Asian origin to Irula tribals. It has been observed that Carabelli's trait is generally bilateral and symmetric. The inconsistency in sexual dimorphism among males and females may be because this trait is population-specific and also because of variation in the methodology and sample sizes[17]. There was no sexual dimorphism noted for this trait in our study.

Cusp of Carabelli was studied in upper first molars and shovelling of teeth in upper incisors in Indo-Nepalese and Tibeto-Nepalese ethnic groups. More occurrence of Carabelli's cusp was found in the former group while shovelling of teeth was obesrved in the latter[18]. Our

findings do not show similarity to either of these ethnic groups due to the increased occurrence of both traits. Cusp of Carabelli and shovelling can serve as predictors of inter-population ethnic differences and may aid in personal identification. The degree of association of these two traits may further facilitate the process. The cusp of Carabelli and shovelled incisor showed maximum frequency in both sexes in ethnic Tamil population in a study by Srivastav et al[19]. These findings correspond with our study wherein these two traits occur with higher frequency. Wearing of the protocone to 1/3rd of the crown height can mask the presence of the cusp of Carabelli, especially in the lower grades. In the maxillary molars, the gradient of wear decreases from buccal to lingual[20]. Yet, due to the rampant and severe chewing habit in tribal populations such as the one in the present study, this fact has to be taken seriously into consideration to avoid underestimation of this trait.

Three cusped first upper molar, which has high incidence in the present study, also shows high incidence in Europeans[8]. Our study shows a 76% incidence, which is very close to the finding of 77% in Europeans by Irish et al. Hanihara, however has observed a higher incidence of this trait in Sub-Saharan Africans. Irish and Hanihara have found low incidence of Cusp 6 in the lower first molar (LM1) in Europeans. The incidence of only 5.7% of this trait in our study aligns with this finding[8] (Table 4). Midline diastema, though ubiquitous, is useful as an African marker[20]. Considerably high occurrence (mean 19.3%) is noted in the present study. This is on par with Sub-Saharan African samples (mean 11.7%)[20].

There were only three cases of double shovelling found in the present study. This could be explained by the relatively high incidence of labial convexity which precludes double shovelling[20]. DAR of canines is the trait that shows maximum gender dimorphism in the human dentition in favour of males[21]. This is reflected in our study. DAR in premolars showed better expression than mesial accessory ridges in a study on Kerala population[9]. The present study supported this finding except in the case of UP1. Metacone (DB cusp) is rarely absent in human dentition[9] and was present in all our samples. Winging showed gender discrimination in a study on related and non-related individuals[21]. We too found sexual dimorphism with respect to this trait.

Of the Premolar Accessory Ridges, DAR is seen more than MAR and more in males than females in a Slavic study[9]. We have also found more DAR than MAR in our study population. Among genders, DAR was found more in males. UP1 was an exception to both the above findings. Bifurcation of hypocone is a trait relatively common in Alaskan Eskimos[22]. This trait was expressed in 3.3% in our study. As wear can make the Anterior fovea difficult to score, grades 3 – 4 should constitute the breakpoint for this trait[9]. Our study revealed only grades 1 and 2 in anterior fovea. Asian and Asian derived populations show little or no labial convexity. This trait is seen in Africans, while European and Pacific populations show intermediate grade[20]. Labial convexity grades 1 and 2 were seen in 38.7% and 13.3% respectively in our study. The overall occurrence of parastyle is low in humans, but shows high incidence in the Indian population [22]. We came across one parastyle in our study.

The traits that exhibit distinct geographic variation may serve as indicators of population affinity in forensic anthropology. The frequency as well as the grade of expression is to be considered in this assessment[8]. The finding of high incidence of shovelling in the present study is seen restricted to lower grades. Tinoco et al in 2015 have assessed the dental anthropology of a Brazilian sample using a selected combination of grades of traits showing geographic variation. This was done in accordance with Hanihara's account of NDCT variations of the major human populations. They found strong affiliation to Sub-Saharan and European races. Similar combinations of trait gradations in our study were assessed using the population affiliation chart of Tinoco et al. The Irula tribals showed most likely affinity to the European complex, followed by African and least to Sino-American and Australian (Table 5).

Limitations and Future Research

This being a population study, a greater sample size is desirable. NDCT need to be evaluated on a larger scale among Irula tribals as well as other tribal population across the country. Deciduous teeth may also be taken up for study. Other dental and oral anatomic features like metric traits, palatal and mandibular dimensions, rugae and skull parameters may also be investigated. The Mean Measure of Divergence is to be calculated to get more specific data on population affiliation.

CONCLUSION

Shoveling and Carabelli's cusp may define the Irula population because of higher incidence and strong manifestation. Fairly high occurrence of midline diastema was noted among Irula. Sexual dimorphism in DAR of canines was observed. Higher frequency of premolar DAR than MAR was seen. DAR was found more in males with UP1 being an exception to both. Labial convexity could not be considered as a trait relevant to this population due to its low incidence and weak expression. Anterior fovea had low incidence and also was not found to constitute the break point as grades

3 and 4 were not found. A population affinity to Caucasians was observed.

DECLARATION

Ethical Approval

Ethical clearance was obtained from the Institutional Ethics Committee (AEC/REV/2022/19)

Acknowledgements

1 We acknowledge the services of Mr Deepak S, Statistician, in computing the statistics and Ms. Athira PK, Dental Mechanic, in cast preparation.

2 Conflict of interests

There are no conflicts of interest.

3 Funding Acknowledgement

Self-financing. There is no external funding.

4 Author Contributions

1.Karunakaran, Anila: Contributed to conception, design, data acquisition, analysis and interpretation, drafted and critically revised the manuscript.

2.Ravindran, Rathy: Contributed to conception, design, data acquisition, analysis and interpretation, drafted and critically revised the manuscript.

3.KK, Sivaprasad: Contributed to design, drafted the manuscript.

4.Kumar Puthenveedu, Ranjith: Contributed to conception and critically revised the manuscript.

All authors gave their final approval and agree to be accountable for all aspects of the work

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