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ORIGINAL RESEARCH ARTICLE

CARABELLI TRAIT AND SHOVEL SHAPED INCISORS AMONG NEWARI CHILDREN OF BHAKTAPUR

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ABSTRACT

Background: Carabelli's trait can be useful in establishing phylogenic relationships between closely related populations. Most of the studies have reported only on permanent maxillary first molar for the Carabelli trait. Studies on the Carabelli trait have been very limited. This study aimed to assess two selected morphometric traits in Newari Children in Bhaktapur.

Methods: This cross-sectional study was conducted among 6-14year old 340 children belonging to the Newar community of Bhaktapur after obtaining the required consent and assent form. Children who had healthy primary second molars and/or permanent first molars were included while severely carious or restored teeth, undergoing orthodontic treatment, having traumatic injuries to teeth, special health care needs, developmental anomalies, attrited cusps and having non-eruption/partial eruption of the desired tooth unilaterally/bilaterally were excluded. Data was collected, and statistical analysis was done. The study was analyzed using the measure of central tendency and measure of dispersion with SPSS software version 16.

Results: The most prominent shovelling trait found in the maxillary central incisor was trace among 41.8% of participants. Cusp of the Carabelli trait was seen in 49.1% in right and 45.6% in left maxillary permanent molars of participants, and small vertical ridge and groove was the most prominent trait among the Carabelli trait of both primary and permanent molars.

Conclusions: Non-metric dental traits can be evaluated for identification of ethnic groups and for clinical management in various dental procedures.

INTRODUCTION

A Carabelli trait is a characteristic morphological structure located on the mesiopalatal surface of the maxillary first permanent molar. It is sometimes observed on the deciduous maxillary second molar and maxillary permanent second molar and rarely in the maxillary third molar.[1,2] It has most commonly been identified bilaterally.[3,4] This typical feature has been suggested to be genetically determined. Few have proposed genetic and exogenous factors as its etiology.[5,6]

Carabelli's trait can be useful in establishing phylogenic relationships between closely related populations.[6, 7] In an observational study,Sarker et a. have reported the Carabelli trait to be present in 52.8%.[1] Ethnicity-based findings were reported by Alamgit et al., suggesting that it was present in the Swati group and Gujers in Pakistan.[8] In a study by Kamatham et al., 89.9% of primary molars, 63.7 % of permanent first molars and 8% of permanent second molars showed Carabelli trait.[9]

Shoveling is another feature displayed by maxillary incisors characterized by the presence of marginal ridges. Many human populations, especially Asian and Native American groups,express shovelling traits. Lingual tubercle with shovelling has been reported to be seen in Neanderthals.[8, 10-12] Kirthiga et al. have shown double shovelling in 66.6%, followed by shovelling in 65.7%.[13]

The association between the two selected morphological traits has been reported.[12] Studies on Carabelli trait has been very limited, with only one study to date in Nepal.[4] Studies have shown the presence of morphological traits in ethnic groups. The Carabelli trait and shovel-shaped incisor trait have not been covered in any ethnic group in Nepal. This study aimed to assess two selected morphometric traits, the Carabelli trait and shovel-shaped incisors, among the Newari Children of Bhaktapur.

METHODS

This descriptive cross-sectional study was conducted among 6 to 14 year old children belonging to the Newar community of Bhaktapur. The study was conducted from July 2020 to August 2021 after obtaining ethical clearance from the Instituitional Review Committee, KMC (Ref: 040320202). Schools from

each of the six municipalities of Bhaktapur were selected for uniformity as most of the ethnic Newars resided in this district. Based on the study by Subedi N et al.,[4] taking p= 68.3%=0.683, q=1-p=0.317 at 95% confidence interval and d=5%=0.05, and using formula $n= Z^2pq/d^2$, the sample size was calculated as 333. However, in the study, 340 schoolchildren of the age group 6-14 years of Newari ethnicity were enrolled. Required consent and assent form the parents and children were obtained after explaining to them about the examination method,and those willing to participate were included in the study.

Only the children who had healthy primary second molars and/or permanent first molars were included, while severely carious or restored teeth were excluded. Children undergoing orthodontic treatment, having traumatic injuries to teeth, special health care needs, developmental anomalies, attrited cusps and having non-eruption/partial eruption of the desired tooth unilaterally/ bilaterally were also excluded from the study.

Intraoral examination was carried out in natural light using a mouth mirror and probe to determine the presence and degree of expression of Carabelli's trait of mesio-palatal cusp of the left and right maxillary primary second molar and permanent first molar and, if possible, the observation of the same in second permanent molars according to the age of the assessed child. In the same way, the shovelling of the maxillary central incisor was recorded. Cotton pellets were used to clean the teeth of food debris and to dry them. Performa was designed to collect the required data. To avoid inter-examiner bias, only one examiner recorded the degree of expression of this trait. In order to reduce the confounding effects of the mixture of races on Carabelli's traits, only subjects who had both parents from Newari origin were chosen. Only the cusp prominence was recorded, and depression or groove was not considered in the study.

In this study, subjective scale[14] was used to grade the degree of shovel shape. Abnormal morphology of the incisors, such as peg-shaped or barrel-shaped incisors, the presence of talon cusp[14] were all recorded.

The Cusp of Carabelli (COC) trait in the present study was determined by the Dahlberg's scale for the determination of the degree and expression of Carabelli cusps.[15]

The study was analyzed using the measure of central tendency and measure of dispersion with SPSS software version 16. The data was presented in tables.

RESULTS

The mean age of the participants in the present study was 9.75 years (SD =1.78). The 340 subjects had a gender distribution of 143 males (42.06%) and females (57.94%). A small vertical ridge was seen among 59(17.4%) participants,while more than half presented with no Carabelli trait on the deciduous right molar. Similarly, the prominent trait in the left deciduous molar was seen to be small vertical ridge and grooves 59(17.4%), while the majority of the participants, 195 (57.4%) didn't present with any Carabelli trait (smooth Mesiopalatal cusp) on deciduous left maxillary molars. Even though 173 (50.9%) of the participants presented with smooth surfaces, sixty-four (18.8%) of participants had small vertical ridges and grooves; small tubercle was seen in 41(12.1%) of the population, and small pit with minor grooves diverging from depression was seen in 22(6.5%) of the participants (Table 1).

Table 1: Cusp of Carabelli trait in deciduous maxillary second molars and permanent maxillary first molars

Cusp of Carabelli trait	16 n(%)	55 n (%)	26 n(%)	65 n (%)
Small vertical ridge and groove	64 (18.8)	59 (17.4)	68 (20.0)	59 (17.4)
Small pit with minor grooves diverging from depression	24 (7.1)	15 (4.4)	18 (5.3)	13 (3.8)
Double vertical ridges /slight and incomplete cusp outline	22 (6.5)	7 (2.1)	19 (5.6)	11 (3.2)
Y form moderate grooves curving in opposite directions	9 (2.6)	6 (1.8)	8 (2.4)	3 (0.9)
Small tubercle	41 (12.1)	14 (4.1)	36 (10.6)	16 (4.7)
Broad cusp outline moderate tubercle	7 (2.1)	6 (1.8)	6 (1.8)	6 (1.8)
Large tubercle with free apex	0	1 (0.3)	0	1 (0.3)
Smooth	173 (50.9)	196 (57.6)	185 (54.4)	195 (57.4)
Exfoliated	0	36 (10.6)	0	36 (10.6)

Table 2: Cusp of Carabelli on permanent first molar with gender

Cusp of carabelli trait	Right		Left	
	Male n (%)	Female n (%)	Male n (%)	Female n (%)
Small vertical ridge and groove	24 (16.8)	40 (20.3)	26 (18.2)	42 (21.3)
Small pit with minor grooves diverging from depression	11 (7.7)	13 (6.6)	7 (4.9)	11 (5.6)
Double vertical ridges /slight and incomplete cusp outline	12 (8.4)	10 (5.1)	10 (7.0)	9 (4.6)
Y form moderate grooves curving in opposite directions	3 (2.1)	6 (3.0)	5 (3.5)	3 (1.5)
Small tubercle	22 (15.4)	19 (9.6)	20 (14.0)	16 (8.1)
Broad cusp outline moderate tubercle	4 (2.8)	3 (1.5)	5 (3.5)	1 (0.5)
Smooth	67 (46.9)	106 (53.8)	70 (49.0)	115 (58.4)

Table 3: Incisal shovelling

Incisal shovelling	Right n (%)	Left n (%)
Trace	143 (42.1)	142 (41.8)
Semi	67 (19.7)	72 (21.2)
Pronounced	8 (2.4)	6 (1.8)
None	120 (35.3)	117 (34.4)
Talon cusp	2 (0.6)	3 (0.9)

The prominent shovelling trait seen in the right central incisor among the participants was trace (42.1%), while 120 (35.3%) didn't show any shovelling patterns, presence of Talon's cusp was seen among 2 (0.6%) of the participants. The left central incisor showed trace shovelling characteristics among 142(41.8%) of the participants, while 142 (41.8%) of participants had none characteristics. Trace shovelling traits in incisors were seen to be more in males (44.1% on the right, 45.5% on the left) than females (40.6% on the right, 39.1% on the left).The permanent maxillary first molar presented with a Smooth cusp on 173(50.9%), while a small vertical ridge and groove were seen among 64(18.8%)of the participants. Similarly permanent maxillary left molar of nearly half of the participants, 185 (54.4%) had smooth mesio-lingual cusps and small vertical ridges, and grooves were seen on 68(20%)of the participants. Small vertical ridges and grooves were seen more in females (20.3% on the right and 21.3% on the left) than in males (16.8% on the right and 18.21% on the left). Small tubercle was seen more in males (15.4% on the right and 14% on the left) than in females (9.6% on the right and 8.1% on the left).

Table 4: Incisor shovelling and gender

Incisor shovelling	Male		Female	
	Right n (%)	Left n (%)	Right n (%)	Left n (%)
Trace	63 (44.1%)	65(45.5%)	80(40.6%)	77(39.1%)
Semi	21(14.7%)	22(15.4%)	46(23.4%)	50(25.4%)
Pronounced	4(2.8%)	3(2.1%)	4(2.0%)	3(1.5%)
None	54(37.8%)	52(36.4%)	66(33.5%)	65(33.0%)
Talon Cusp	1(0.7%)	1(0.7%)	1(0.5%)	2(1.0%)
Total	143(100.0%)	143(100.0%)	197(100.0%)	197(100.0%)

DISCUSSION

Rich in architecture, cultural performance, and social diversity, the city of Bhaktapur, in Nepal's Kathmandu Valley, endures as one of the great surviving traditional cities of Asia.[16] Newars are generally seen as a Tibeto-Burman race or of Mongoloid origin, but there is a racial admixture of two or more races in almost all South-Asian phenotypes. But the truth is that Newars as a whole cannot be taken as one sample as there is a lot of historical precedence.[17]

Morphologic traits and characteristics have been utilized by anthropologists in assessing human populations and evolutionary patterns of expression.[18] The resemblance of an incisor to a shovel results from the combination of a concave lingual surface with elevated marginal ridges.[19] Shoveling trait was seen to be more common in permanent than primary incisors teeth. Shoveling has been associated with mongoloid population irrespective of geographic region.[20]

Trace shovelling trait was seen among 42.1% of the studied population in this study, while Semi was seen among 21.2%, which was low in comparison to southern Chinese populations, which showed 48.6% in central incisors[20] while it showed similarity in a study done by Ling and Wong [14]where trace was seen to be present in 27% of central incisors studied. Even though Newari children might be associated with mongoloid origin, the variations in this study could be the racial admixture of South Asian phenotype.[17] Trace shovelling trait was seen more in males (44.1% on the right,45.5% on the left) than females (40.6% on the right, 39.1% on the left) but was statistically insignificant.

Shovelling presents clinical challenges while managing the orthodontic reduction of increased overjet, and it requires reshaping of marginal ridges. The orthodontic treatment plan for those with shoveling will be different from that for those who do not have the trait.[14] More natural reconstruction of crown morphology might be needed in shoveling, especially in cases of crown fracture due to trauma. Talon cusp is a cusp-like hyperplasia arising from the cingulum area of the maxillary and mandibular teeth. It poses a series of clinical problems like susceptibility to caries, occlusal trauma, loss of esthetics, irritation to the tongue during speech and mastication, and advanced attrition causing pulpal exposures.[14] The frequency of talons cusp was only seen in 0.6% of the participants, indicating a low prevalence, which was similar to the study done by Ling and Wong [14,] who showed the occurrence of one in central incisor and 2% for lateral incisor.

Primary maxillary second molars having a Cusp of Carabelli (COC) trait are more susceptible to dental caries, and the position of the cusp can pose a challenge in the placement of bands for space maintenance.[20] In our study, 36(10.6%) had exfoliated primary second molars bilaterally, indicating the normal exfoliation pattern among the age groups. As 57.4% of the participants had smooth Mesiopalatal cusps, the COC traits were seen only among (42.4% on the right side and 42.6% on the left side) of the participants, which was less compared to the study by Kannapan and Swaminathan, which showed 67.5% in primary and 52.77% in permanent. [21]

Various studies[23-26] have described the COC being found in hominid (early human) species Australopithecus and Neanderthal man, with suggestions of an evolutionary

development from a small groove to a well-pronounced cuspal growth. It is well known that the frequency of Carabelli Trait varies from population to population within groups.[22]. The frequency is highest among modern Europeans (70%-90%) and lowest among Asian populations (35%-45%).[23-28] Researchers used intra-oral examination, dental casts or both to format studies on the Cusp of Carabelli. The present study included only the intra-oral examination method as it provided the advantages of accurate recording, proper identification of teeth, and follow-up of the patients when needed.[15]

A study done in the Nepalese population by Subedi N et al.[4] showed that 205 (68.3%) of the cases had the presence of Carabelli trait on either of the first molars. Though the frequency of occurrence of the trait was higher, the cusp as a separate entity was found only in very few cases in 16 and 26 while none in 17 and 27. In contrast, our study had 49.1% of the participants with COC traits, which included small vertical ridge 7.1%, slight /incomplete cusp outline 6.5%, small tubercle 12.1%, and moderate tubercle 2.1%. The use of different classifications, Goose and Lee by Subedi N et al.[4] and the inclusion of various ethnic groups in Madi, Chitwan could lead to more diverse observations than the present study. Yet the prevalence of the Carabelli trait in the study falls near to the range of observations in the Asian population ((35%-45%). [23-28]

The study done by Sah et al. in 2019[29] among Indo-Nepalese and Tibeto-Nepalese aged 14 years old children showed a lesser prevalence of cusp of Carabelli in Tibeto-Nepalese (37.19%) than this study (49.1%) but the shovelling characteristic was seen to be higher (65.28%) compared to the present study. The higher prevalence could be due to the inclusion of both central and lateral incisors in the previous study.[29] Studies by Kannapan and Swaminathan[21] showed that 52.77% of permanent teeth had a nearly close prevalence to the present study (49.1%).

The limitation of the study is the sampling technique, as we are using a convenience sampling method along with a small sample size. Generalizability cannot be done as it is ethnically based study.

CONCLUSION

Non-metric dental traits can be evaluated for the identification of ethnic groups. The most prominent shovelling trait found was trace among the participants. The cusp of Carabelli trait was seen in nearly half of the maxillary permanent molars of participants, and a small vertical ridge and groove was the most prominent trait among the Carabelli trait of both primary and permanent molars.

CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None

REFERENCES:

1. Sarker S, Hossain MM, Saki N, Mahjebin F, Sultana R, Ahmed G. The frequency of the Carabelli trait in selected Bangladeshi population. KYAMC J. 2019;9(4):163-5. [DOI]
2. Alothman S, Mohammed S, Alrabai N, Asiri A, Alshahrani I, Togoo R, Zakirulla M. Variation in the buccal surface morphology of primary first molars among Saudi children. International Journal of Medical Dentistry. 2019;9(1):74-8. [LINK]
3. Karale R, Chikkamallaiah C, Hegde J, Aswathanarayana S, Santhosh L, Bashetty K, et al. The prevalence of bilateral three-rooted mandibular first molar in Indian population. Iran Endod J. 2013;8(3):99-102. [PMID]
4. Subedi N, Sah S, Chataut TP, Paudel S, Pradhan A. The prevalence of the carabelli trait in selected Nepalese population. [DOI]
5. Kimura R, Yamaguchi T, Takeda M, Kondo O, Toma T, Haneji K, et al. A common variation in EDAR is a genetic determinant of shovel-shaped incisors. The American Journal of Human Genetics. 2009 Oct 9;85(4):528-35. [DOI]
6. Hunter JP, Guatelli-Steinberg D, Weston TC, Durner R, Betsinger TK. Model of tooth morphogenesis predicts Carabelli cusp expression, size, and symmetry in humans. PloS one. 2010 Jul 29;5(7):e11844. [DOI]
7. Falomo OO. The cusps of Carabelli: frequency, distribution, size and clinical significance in Nigeria. West African journal of medicine. 2002;21(4):322-4. [DOI]
8. Masud A, Burki M. Study on tooth morphological variations among various ethnic groups of Pakistan.Pakistan Oral & Dental Journal. 2018;38(2).
9. Kamatham R, Nuvvula S. Expression of Carabelli trait in children from Southern India - A cross sectional study. J Forensic Dent Sci. 2014;6(1):51-7. [DOI]
10. Bailey S. Beyond shovel-shaped incisors: Neandertal dental morphology in a comparative context. Periodicum Biologorum. 2006 Oct 31;108(3):253-67.
11. Denton L. Shovel-shaped incisors and the morphology of the enamel-dentin junction: an analysis of human upper incisors in three dimensions [tesis]. Colorado: Universidad del Estado de Colorado Departamento de antropología. 2011.
12. Kirthiga M, Manju M, Praveen R, Umesh W. Ethnic Association of Cusp of Carabelli trait and shoveling trait in an Indian population. Journal of clinical and diagnostic research: JCDR. 2016 Mar;10(3):ZC78. [DOI]
13. Kirthiga M, Manju M, Praveen R, Umesh W. Prevalence of aberrant dental morphological details in 6-10 year old school children in an Indian population. Contemporary clinical dentistry. 2015 Sep 1;6(Suppl 1):S175-80. [DOI]
14. Ling JY, Wong RW. Incisal morphology of southern Chinese. The Open Anthropology Journal. 2008;19-25. [DOI]
15. Mosharraf R. Prevalence of the Carabelli trait in Iranian adolescents. SRM Journal of Research in Dental Sciences. 2013 Jan 1;4(1):12-5.[DOI]
16. Lewis, Todd T. Book review of '" 'Mesocosm: Hinduism and the Organization of a Traditional Newar City in Nepal'" Nepal' by Robert I. Levy (with Kedar Raj Rajopadhyaya). HIMALAYA. 1994; 14(1).
17. Nepal federation debate. Nepal federalism debate.wordpress.com posted on May 11, 2015.
18. Owens BM, Phebus JG,Blen BJ, Redmond DC . Cusp of Carabelli : Observations of an Odontogenic Trait. Dent Adv Res 2016; 1:102. [DOI]
19. Hrdlicka A. Shovel shaped teeth . Am J Phys Anthropol 1920;3: 429-66. [DOI]
20. King NM, Tsai JSJ, Wong HM. Morphological and numerical characteristics of the southern Chinese dentitions.Part II: Traits in the premanent

dentition. The Open Anthropology Journal 2010; 3: 71-84. [DOI]

21. Kannapan JG, Swaminathan S. A study on a dental morphological variation. Tubercle of Carabelli. Indian journal of dental research: official publication of Indian Society for Dental Research. 2001 Jul 1;12(3):145-9. [PMID]
22. Scott GR. Population variation of Carabelli's trait. Human biology. 1980 Feb 1:63-78. [PMID]
23. Duttargi AN, Prasad PR, Sreeshyla HS. Accessory cusp: Cusp of Carabelli-A brief review. Indian Journal of Multidisciplinary Dentistry. 2013 Jul 1;3(4):799. [LINK]
24. Dahlberg AA. Analysis of the American Indian dentition. InDental anthropology 1963 Jan 1 (pp. 149-177). Pergamon. [DOI]
25. Kraus BS. Carabelli's anomaly of the maxillary molar teeth; observations on Mexicans and Papago Indians and an interpretation of the inheritance. Am J Hum Genet. 1951 Dec;3(4):348-55. [PMID]
26. Reid C, Van Reenen JF. The Carabelli trait in early South African hominids: a morphometric study. Aspects of Dental Biology: Paleontology, Anthropology and Evolution. International Institute for the Study of Man, Florence. 1995:299-304.
27. Wood BA, Engleman CA. Analysis of the dental morphology of Plio-Pleistocene hominids. V. Maxillary postcanine tooth morphology. Journal of Anatomy. 1988 Dec;161:1.
28. Hillson S (1996) Variation in size and shape of teeth. In: Hillson S (ed.). Dental Anthropology. Cambridge University Press, UK. Pg no: 91.[DOI]
29. Sah SK, Kandel S, Shrestha R, Atreya A. Prevalence of selected non-metric dental traits in Indo-Nepalese and Tibeto-Nepalese ethnic groups of western hilly region. JNMA: Journal of the Nepal Medical Association. 2019 Sep;57(219):323. [DOI]