Evaluation of Occlusal Groove Patterns of Mandibular First and Second Molars in an Indian Population: A Forensic Anthropological Study

Abstract

Background: The study of dental morphological characteristics is important in anthropological research as it can provide information on the phylogenetic relationship between species, as well as variations and diversities within a population. Aims and Objectives: To determine the prevalence of six types of mandibular second molars in Gujarat state and the results can be used in both forensic anthropological researches and clinical aspects of dental sciences. Materials and Methods: This descriptive investigation was undertaken among 1000 students (13–25 years old) in high schools and dental institutes of Gujarat state. The students were selected by cluster sampling method and screened for the number of cusps and groove patterns of mandibular first and second molars. Gender and religion of the students were recorded on prepared forms. Statistical Analysis: It was done with the help of STATAIC-13 software. Descriptive statistics were used to summarize the data and Pearson’s Chi-square test was used to check association between variables. Throughout the discussion, level of significance was set at 5%. Results and Conclusion: The high percentage of “+”-shaped groove pattern and low percentage of primitive “y”-shaped pattern in our study shows a tremendous evolutionary trend persisting in this population. The analysis of dental morphological traits is crucial in anthropological research as it can provide data on the phylogenetic relationship between species, as well as variations and diversities within a population.

Keywords: Anthropology, cusp numbers, mandibular molars, occlusal groove patterns

Introduction

The permanent mandibular first and second molars are known to have a simple morphological pattern that consists of four cusps, placed on a square occlusal surface and a cruciform (+) groove pattern. However, variations in size, cusp number, and groove pattern have been observed in mandibular molars of different populations.[1]

Dental anthropology, a useful tool to identify geographic or racial affinities, is the study of origin and the variations in human dentition.[2] Dento-anthropologic structures beneficial for identification purposes include cusp size, their number and location, occlusal groove pattern, root configuration, number and arrangement of teeth, and individual tooth measurements.[1,3] The collection of data on these morphological traits of teeth in divergent populations has led anthropologists to become more concerned with their evolutionary significance and the mode of inheritance. Various morphological traits of the dentition are likely to be inherited. A less discovered field of dental anthropology is forensic anthropology. It is a specialized area of physical anthropology, which deals with the identification of human remains for legal purposes.[4] A small number of studies have been done in forensic anthropology based on occlusal morphology of permanent mandibular first and second molars.[5]

The permanent mandibular molars feature the protoconid (mesiobuccal), hypoconid (distobuccal), and mesoconid (hypoconulid) cusps on their buccal aspect and the metaconid (mesiolingual) and entoconid (distolingual) on their lingual aspect. The variations in contact of these cusps define various groove patterns.[6] In anthropological studies, morphological categories used to describe the variations in occlusal surfaces of the mandibular molars are based on a topology developed by Gregory and Hellman: 5y, 4y, +5, and +4.[7] During human evolution, these occlusal groove patterns have changed “y” to “+.”[7] The norm for determining whether a pattern is a “y” or a “+” is contact of the metaconid (mesiolingual cusp) with the hypoconid (distobuccal cusp). If contact...
occurs, the pattern resembles a “y;“ if no contact occurs, it resembles a “+.”  Therefore, a total of six occlusal groove patterns are discerned in permanent mandibular molars: +4, 4y, +5, 5y, +6, and 6y. Here, groove patterns are “+” and “y” and 4, 5, and 6 are the number of cusps present [Figure 1].

The groove pattern and the number of cusps are determined independently, and their evolutionary changes are not well correlated phenotypically. They exhibit varied expressions in dentitions of different populations. The final tooth form is a culmination of its genetic endowment and long-term environmental influences.

The molar occlusal groove patterns are determined by a combination of allele on two or more loci, and they occur in the final stages of molar growth, as a result of the terminal deposition of enamel. According to anthropologists and paleontologists, the “y”-shaped groove pattern is the most conservative, and the “+” is the most evolved occlusal groove pattern. A lower molar with Y groove pattern and five to six cusps occurred in Dryopithecus. From here, the number of cusps has been reduced, and alteration in their size and position is possible.

It is believed that the numerous morphologic characteristics of the teeth are genetically determined and that simple Mendelian inheritance is unlikely in these traits. Therefore, they are likely to be inherited in a multifactorial way. An explicit description and study of these traits could provide valuable information regarding phylogeny of man and distinctions between races and subraces. Furthermore, a cognizance of variations in dental morphology can aid in performing basic dental treatments.

The present descriptive study was undertaken to investigate the prevalence of six types of occlusal groove patterns in mandibular first and second molars in the age group of 13–25 years in an Indian population of Gujarat state.

Materials and Methods

The study was approved by the Institutional Ethical Committee.

It was a descriptive study completed in the duration of 3 months. Inclusion criteria for the selection of samples were to include the students of Gujarat state of age group of 13–25 years with erupted mandibular first and second molars bilaterally, whereas the exclusion criteria were to exclude carious, restored, or broken teeth and teeth with developmental defects of the structure and shape. A total of 1000 students were selected using cluster sampling method from two high schools and two dental colleges of Vadodara and Jamnagar cities, after taking prior permission from the respective institutes. Two dental professionals were trained for the purpose of screening. The criteria given by Gregory and Hellman for determining whether a pattern is “y” or “+” were followed which depends on contact of the metaconid (mesiolingual cusp) with the hypoconid (distobuccal cusp). If the contact occurs, the pattern resembles a y. If no contact occurs, the pattern resembles a +. A pilot study was done on fifty dental students where the two examiners independently recorded the data under the supervision of a professor so as to avoid any interobserver variation while scoring the actual samples. The data of pilot study were not included in the actual sample. Direct intraoral examination was done carefully, and morphological details of the crown, namely, the number of cusps and groove patterns of teeth along with the name, age, gender, and ethnicity of the samples were recorded. The data thus collected were tabulated and subjected to statistical analysis.

Statistical analysis

It was done with the help of STATA/IC-13 software (StataCorp). Descriptive statistics were used to summarize the data and Pearson’s Chi-square test was used to check association between variables. Throughout the discussion, level of significance was set at 5%.

Results

Out of the 1000 people examined, 344 (34.4%) were males and 656 (65.6%) were females. In this population, five-cusp form (74.7%) was the most frequent in first permanent molars, whereas the four-cusp form (88.4%) was the most frequent in second permanent molars. The predominant groove pattern was “y” (58.25%) for first molars and “+” (90.1%) for the second molars [Table 1].

About 20.55% (n = 411) mandibular first molar showed four-cusp pattern, 74.7% (n = 1494) showed five-cusp pattern, and 4.75% (n = 95) showed six-cusp pattern. Nearly 88.4% (n = 1768) of mandibular second molar showed four-cusp pattern followed by 10.8% (n = 216) of five-cusp pattern. Almost 41.75% (n = 835) of the mandibular first molar showed “+” and 58.25% (n = 1165) showed “y” groove pattern. About 90.1% (n = 1802) of the mandibular second molar showed “+” pattern with only 9.9% (n = 198) showing “y” groove pattern [Table 1].

The most frequent occlusal groove pattern was 5y (1004) for the first molars and 4+ (1675) for the second molars. The 7+ pattern was seen only in one case with mandibular left permanent molar exhibiting it [Tables 2 and 3].
Table 1: Distribution of cusps and groove patterns in permanent mandibular molars

| Tooth* | 36 (left) | 46 (right) | Total (n=2000), n (%) | 37 (left) | 47 (right) | Total (n=2000), n (%) |
|--------|-----------|------------|-----------------------|-----------|------------|-----------------------|
| 4 cusp | 201       | 210        | 411 (20.55)           | 870       | 898        | 1768 (88.4)           |
| 5 cusp | 756       | 738        | 1494 (74.7)           | 124       | 92         | 216 (10.8)            |
| 6 cusp | 43        | 52         | 95 (4.75)             | 5         | 10         | 15 (0.75)             |
| 7 cusp | 0         | 0          | 0                     | 1         | 0          | 1 (0.05)              |
| +      | 430       | 405        | 835 (41.75)           | 888       | 914        | 1802 (90.1)           |
| Y      | 570       | 595        | 1165 (58.25)          | 112       | 86         | 198 (9.9)             |

*FDI system is used for notation of teeth. FDI=Fédération dentaire international

The most common form found bilaterally is 5y (57.8%), with the least common form being 6+ (0.7%) for the first molars [Table 4]. For the second molars, the most common form found bilaterally is 4+ (94%) [Table 5].

The rates of each type of occlusal patterns between males and females had no significant differences in permanent mandibular left first molar, left and right second molars. However, 4+, 5+, and 5y forms showed significantly higher rates in females in permanent mandibular right first molars (p < 0.05) [Table 6].

Discussion

Very few dental anthropological studies have been done on occlusal morphology of mandibular molars in humans. In such studies, intraoral examination, study of dental casts, or both methods have been used. Direct intraoral examination provides accuracy in tooth identification and ensures racial and sexual identification.\[1,14\]

Hellman classified mandibular molars based on the occlusal pattern and the number of cusps. According to him, the basic pattern is “5y,” with five cusps and a “y-”shaped occlusal configuration.

The permanent mandibular molars are usually characterized by four cusps, two placed buccally and two lingually. The five-cusp forms have been commonly reported in the dentitions of mongoloid origin. The prevalence and features of the mandibular second molars were investigated in a Singaporean sample of 380 participants with the bilateral presence of mandibular second molars. Almost 43.1% of cases showed the bilateral occurrence of five-cusp forms, whereas 8.9% of cases had unilateral occurrence. Loh stated that the distobuccal cusp (hypoconulid) is the most variable, and in the evolutionary advanced type, it disappears leading to a four-cusp form.\[1\] He noticed a relatively high incidence of five-cusp second molars in the Singaporean population.

According to a study by Mosharraf et al., the most frequent occlusal configuration for permanent mandibular second molar was “4+” form (76.9%) in Iranian population and the most common form found bilaterally was “4+” (71.4%).\[2\] This remains in concordance with the present study.

Five-cusp second molars were the most prevalent in a study on Southern Chinese population. Different from traditionally described, the Southern Chinese has more five-cusp lower second molars than the four-cusp ones.\[13\]

Table 2: Occlusal morphology of mandibular first molars (36, 46)

| Occlusal morphology | Left (%) | Right (%) | Total |
|---------------------|----------|-----------|-------|
| 4+                  | 157 (15.7) | 157 (15.7) | 314   |
| 4y                  | 44 (4.4)  | 53 (5.3)  | 97    |
| 5+                  | 264 (26.4)| 226 (22.6)| 490   |
| 5y                  | 492 (49.2)| 512 (51.2)| 1004  |
| 6+                  | 9 (0.9)   | 22 (2.2)  | 31    |
| 6y                  | 34 (3.4)  | 30 (3.0)  | 64    |
| Total               | 1000 (100)| 1000 (100)|       |

Table 3: Occlusal morphology of mandibular second molars (37, 47)

| Occlusal morphology | Left (%) | Right (%) | Total |
|---------------------|----------|-----------|-------|
| 4+                  | 816 (81.6)| 859 (85.9)| 1675  |
| 4y                  | 54 (5.4)  | 39 (3.9)  | 93    |
| 5+                  | 67 (6.7)  | 48 (4.8)  | 115   |
| 5y                  | 57 (5.7)  | 44 (4.4)  | 101   |
| 6+                  | 4 (0.4)   | 7 (0.7)   | 11    |
| 6y                  | 1 (0.1)   | 3 (0.3)   | 4     |
| 7+                  | 1 (0.1)   | 0         | 1     |
| Total               | 1000 (100)| 1000 (100)|       |

Table 4: Bilateral symmetry of occlusal morphology in mandibular first molars (36, 46)

| Occlusal morphology | Frequency of bilateral symmetry (n=545), n (%) |
|---------------------|-----------------------------------------------|
| 4+                  | 101 (18.5)                                   |
| 4y                  | 16 (2.9)                                      |
| 5+                  | 98 (18.0)                                     |
| 5y                  | 315 (57.8)                                    |
| 6+                  | 4 (0.7)                                       |
| 6y                  | 11 (2.0)                                      |

Table 5: Bilateral symmetry of occlusal morphology in mandibular second molars (37, 47)

| Occlusal morphology | Frequency of bilateral symmetry (n=797), n (%) |
|---------------------|-----------------------------------------------|
| 4+                  | 749 (94)                                      |
| 4y                  | 12 (1.5)                                      |
| 5+                  | 20 (2.5)                                      |
| 5y                  | 13 (1.6)                                      |
| 6+                  | 2 (0.3)                                       |
| 6y                  | 1 (0.1)                                       |
study shows the five-cusp form to be most common for mandibular first molars, whereas the four-cusp form to be the most common for mandibular second molars.

During human evolution, the morphology of mandibular molar occlusal grooves has changed from the pattern “y” to pattern “+.” Six types of occlusal grooves were classified as y5, y4, +5, +5, X5, and X4.[7]

Morphological study on the occlusal groove of mandibular molar of Chinese adults showed “5y” to be the most prevalent pattern in mandibular first molars. “4+” was the most common and “5y” was the least common pattern for mandibular second molars. The rates of each type of groove pattern between males and females had no significant difference.[7] The present study also shows similar findings with “5y” to be the most common pattern for mandibular first molars and “4+” for the mandibular second molars.

Morphologic characteristics of the permanent dentition of 63 coastal and 33 inland Alaskan Eskimos revealed the predominant pattern to be “5y” for mandibular first molars where “5+” and “4+” were the dominating patterns for the second mandibular molars.[15] This goes in concordance with the present study.

A study on the distribution of groove patterns and presence of hypoconulid in the permanent mandibular molars of 1010 Icelanders showed a considerable modification of the ancestral y-pattern, as anticipated in a Caucasian population. Neither the sexes nor the subpopulations showed significant differences in the groove patterns. The absence of the hypoconulid on the first molar was significantly more common in females than in males.[16]

Another study revealed that 71.5% of mandibular first molars showed five-cusp pattern and 93.5% of mandibular second molars showed four-cusp pattern. The most frequent configuration for mandibular first molars was “5y” (47%) and for the mandibular second molars was “4+” (88.5%).[5] These results are seen in concordance with the present study where five-cusp and “5y” are the predominant patterns for mandibular first molars, whereas four-cusp and “4+” patterns are predominant for the mandibular second molars.

### Conclusion

The high percentage of “4+”-shaped groove pattern and low percentage of primitive “y”-shaped pattern in our study shows a tremendous evolutionary trend persisting in this population. The analysis of dental morphological traits is crucial in anthropological research as it can provide data on the phylogenetic relationship between species, as well as variations and diversities within a population. Furthermore, knowing common variations in dental morphology can aid in performing some dental treatments.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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