

THE GROOVE CONFIGURATION OF MANDIBULAR MOLARS OF MALAYSIANS OF MONGOLOID ANCESTRY

Configuración del surco de los molares mandibulares de los malayos de ascendencia mongoloide

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ABSTRACT

Aim: Variation in dental structures is widely accepted as a combination of multiple factors such as gender, environmental effects and genetics. However, the characterization of similarities and differences in dental morphology has been lacking in relation to the factors mentioned. This study aims to assess and compare the variations in traits in mandibular molars and the influence of gender and ethnicity in affecting these traits amongst the Malaysian population of Mongoloid ancestry.

Materials and Methods: Our study population was 180 dental casts of patients, from 15 to 40 years old, comprising 56 Malays and 124 Chinese; 60 were males and 120 were females. Traits like groove pattern, number of cusps, protostylids and deflecting wrinkles were observed, scored, and recorded.

Results: This study revealed that the most common mandibular first molar (M1) was characterized by 5 cusps and displayed 'Y' groove pattern, while the most common mandibular second molar (M2) had 4 cusps and exhibited a groove pattern that resembled a '+'. Notably, all the traits studied were bilaterally symmetrical, except for the groove pattern of M1, while sexual dimorphism was observed in groove patterns of M2.

Conclusions: This study found that M1 had a preponderance of 5 cusps with 'Y' groove pattern, while M2 were typically 4-cusped with '+' groove pattern.

Keywords: *Malaysia; Asian people; Ethnicity; Gender; dental anatomy; molar.*

RESUMEN

Objetivo: La variación en las estructuras dentales es ampliamente aceptada como el resultado de una combinación de múltiples factores como el género, los efectos ambientales y la genética. Sin embargo, ha faltado la caracterización de similitudes y diferencias en la morfología dental en relación a los factores mencionados. Este estudio tiene como objetivo evaluar y comparar las variaciones en los rasgos de los molares mandibulares y la influencia del género y la etnia al afectar estos rasgos entre la población malaya de ascendencia mongoloide.

Materiales y Métodos: Nuestra población de estudio fue de 180 modelos dentales de pacientes, de 15 a 40 años, conformados por 56 malayos y 124 chinos; 60 eran hombres y 120 eran mujeres. Se observaron, puntuaron y registraron rasgos como el patrón de surcos, el número de cúspides, los protostilidos y las arrugas desviadas.

Resultados: Este estudio reveló que el primer molar mandibular más común (M1) se caracterizaba por 5 cúspides y mostraba un patrón de ranura en 'Y', mientras que el segundo molar mandibular más común (M2) tenía 4 cúspides y exhibía un patrón de ranura que se parecía a un '+'. En particular, todos los rasgos estudiados eran bilateralmente simétricos, excepto el patrón de surco de M1, mientras que se observó dimorfismo sexual en los patrones de surco de M2.

Conclusión: Este estudio encontró que M1 tenía una preponderancia de 5 cúspides con un patrón de ranura en 'Y', mientras que M2 tenía típicamente 4 cúspides con un patrón de ranura '+'.
Palabras Clave: *Malasia; Pueblo Asiatico; Etnicidad; Genero; Anatomía dental; Diente molar.*

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INTRODUCTION

In the field of paleoanthropology, tooth morphology is considered an important contributing factor in explaining the evolutionary changes from fossilized hominids to modern humans.¹ Tooth morphology holds an abundance of information from the diet of an individual, race-specific affiliation, age estimation to the migratory pattern of a population. Therefore, there is a variation in tooth morphology among individuals within a population, as well as distinct differences between various groups of humans. Thus, the term “races” is defined as a division of species that has distinct hereditary traits that differ from other divisions.²

Malaysia is a diverse multiethnic and multicultural country with population includes Malays, Chinese, Indians, indigenous peoples and, other minor ethnic groups. Generally, these ethnicities can be classified into two main groups which are the Mongoloids and the Indo-Europeans. The Mongoloids comprise the Malays, Negritos (Jahai) and Chinese while the Indo-Europeans include Indians, Pakistanis and Sri Lankan. In general, the Mongoloids can be further subdivided into two major patterns with differing penetration of dental variations namely Sundadont and Sinodont. The Sundadont profiles in Malaysia are represented by the Jahai and Malays while they can also be seen distributed throughout Indonesia and Polynesia.³

Groove pattern can be defined as the basic arrangement of grooves and cusps of the occlusal surface of deciduous and permanent molars. The type of groove patterns in the mandible can be characterized by means of

contact pattern of the cusp.⁴⁻⁶ These include “X”, “Y” and “+” patterns. ‘Y’ is considered as the ancestral pattern and in contrast, ‘X’ and ‘+’ forms are a reduction or absences.⁷ Groove pattern is characterized as ‘X’ when the distolingual cusp and mesi-obuccal cusp are in contact. The pattern of the intercuspal contact groove is considered as a ‘Y’ pattern or “Dryopithecus” when the centrobuccal cusp and mesiolingual cusp are in contact. This ‘Y’ pattern has a stronger genetic control as this native pattern is still conserved in some Asian populations. The ‘+’ pattern occurs when all 4 cusps contact each other and it is assumed that the interbreeding of different racial types has a higher tendency toward the ‘+’ pattern, a characteristic of the Caucasoid population.⁷

In the other two studies done by Garn & Lewis.^{8,9} demonstrated that the groove patterns were expressed independent of mesiodistal width of tooth in mandibular first molars. A comparable finding was reported when analyzing the sizes of the mandibular second and third molars.¹⁰

Moreover, Goose and Lee stated that the most common dental characteristics such as size, presence, number of cusp as well as groove pattern can be used to measure the extent of variation among races as they are genetically determined.¹¹ However, these traits are constantly evolving due to natural selection, genetic and environmental changes with time. This is also the reason that groove patterns and number of cusps are always been described together even though they are independent characteristics from each other.¹² In view of this, the dento-anthropological study of the

coronal morphology, especially the prevalence of the number cusps and groove pattern can be used to assist in the determination or identification of persons for Malaysians as the majority (92.7%) of Malaysians are ethnically classified as Malays and Chinese which belong to Mongoloid race.¹² The subtle differences researched can be a useful tool in determining the racial or ethnic affiliation of these Malaysians with other populations in the world.⁷

Therefore, the aim of this study was to compare the traits in mandibular molars of Malaysians of Mongoloid ancestry. The primary research objective of this study is to compare groove patterns and number of cusps of permanent first and second mandibular molars of selected ethnic Malays and Chinese. In addition, an assessment to be made to determine bilateral symmetry of these traits and associate the variations with gender and ethnicity factors.

MATERIALS AND METHODS

This study was conducted at the Faculty of Dentistry, MAHSA University. Dental casts were obtained from patients who sought treatment at the Department of Orthodontics. This study was approved by the Medical Ethics Committee of the Faculty in accordance with the Declaration of Helsinki. The patients largely resided in Kuala Lumpur, Selangor and nearby districts.

A total number of 200 mandibular casts were obtained and examined by at least 2

investigators to ensure that there should be concordance in findings. These study casts were prepared from an alginate impression of orthodontic patients' dentitions and plaster of Paris or dental stone was poured into them. The sociodemographic data such as gender and ethnicity were subsequently obtained from departmental records.

The inclusion criteria for the cast selection (Figure. 1) is the presence of completely erupted permanent mandibular molars with all cusps and groove patterns being obvious. While on the contrary, the exclusion criteria were due to any presence of restorations and prosthesis, caries and congenital defects or deformities noticed on the molars. The presence of only unilaterally erupted permanent mandibular first and second molars were also excluded from this study.

Finally a total of 180 mandibular casts were employed in the present study as the other 20 casts did not meet the inclusion criteria.

The cusps numbers were counted by identifying the number of pyramidal projections on the occlusal surface of the first and second molars. The "X", "Y" and "+" groove patterns were identified according to Figure 2 (1997), where the "X" groove pattern is characterized when the distolingual cusp and the mesiobuccal cusp are in contact. "Y" groove pattern is considered when the centrobuccal (distobuccal) cusp and the mesiolingual cusp are in contact.

The "+" groove pattern is identified when all 4 cusps are in contact with each other. Groove pattern '-' are the groove patterns that do not fit within the description and characteristics of the other three determined in the classification.

Photographs of the orthodontic casts with a measuring tool were taken as evidence using a 12-megapixel camera and the findings were recorded and stored on a Microsoft Excel spreadsheet in their respective categories; subsequently they recordings were transferred to SPSS software where the data was generated. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0. Armonk, (NY: IBM Corp) with a level of significance set at $p < 0.05$.

RESULTS

A total of 180 mandibular casts were examined and selected for analysis, resulting in a total 360 mandibular first and second molars included in this study. Of the selected casts, 56 were from Malay patients, while 124 were from Chinese patients. For the gender distribution, 60 were male and 120 were female patients. Number of cusps was analyzed according to ethnicity and gender (Figure 3). The first

molars mostly had 5 cusps, while for the second molars it was 4 cusps.

Groove Pattern

Groove patterns 'X', 'Y', '+' were determined according to the Scott & Turner Classification (1997),⁷ whereas groove pattern '-' are the groove patterns that do not fit within the description and characteristics of the classification.

The histograms (Figure 4) show the different distribution of groove patterns among gender and ethnicity groups.

Bilateral Symmetry of number of cusps

There was no significant difference in mandibular right first molar (mean=5.06±0.350) and mandibular left first molar (mean=5.08±0.377) ($p=0.373$). There was no significant difference in mandibular right second molar (mean=4.48±0.570) and mandibular left second molar (mean=4.57±0.627) ($p=0.026$). Hence, the patients in this study displayed bilaterally symmetry in cusps.

Table 1. Variations on groove pattern observed on mandibular first and second molars based on ethnicity, genders and sides.

Variables	Group		n (%)				p-value
			X	Y	+	-	
Groove Pattern (M1)	Ethnicity	Chinese	78 (31.5)	96 (38.7)	48 (19.4)	26 (10.5)	0.026
		Malay	22 (19.6)	26 (50.0)	16 (14.3)	18 (16.1)	
	Gender	Male	38 (71.7)	52 (43.3)	20 (16.7)	10 (8.3)	0.336
		Female	62 (25.8)	100 (41.7)	44 (18.3)	34 (14.2)	
	Side	Left	70 (38.9)	60 (33.3)	36 (20.0)	14 (7.78)	<0.001
		Right	30 (16.7)	92 (51.1)	28 (15.6)	30 (16.7)	
Groove Pattern (M2)	Ethnicity	Chinese	68 (27.4)	30 (12.1)	140 (56.5)	10 (4.0)	0.013
		Malay	14 (12.5)	18 (16.1)	72 (64.3)	8 (7.1)	
	Gender	Male	14 (11.7)	14 (11.7)	82 (68.3)	10 (8.3)	0.001
		Female	68 (28.3)	34 (14.2)	130 (54.2)	8 (3.3)	
	Side	Left	42 (23.3)	22 (12.2)	108 (60.0)	8 (4.4)	0.878
		Right	40 (22.2)	26 (14.4)	104 (57.8)	10 (5.6)	

Figure 1. The occlusal surface shows excellent groove pattern and cusps numbers.

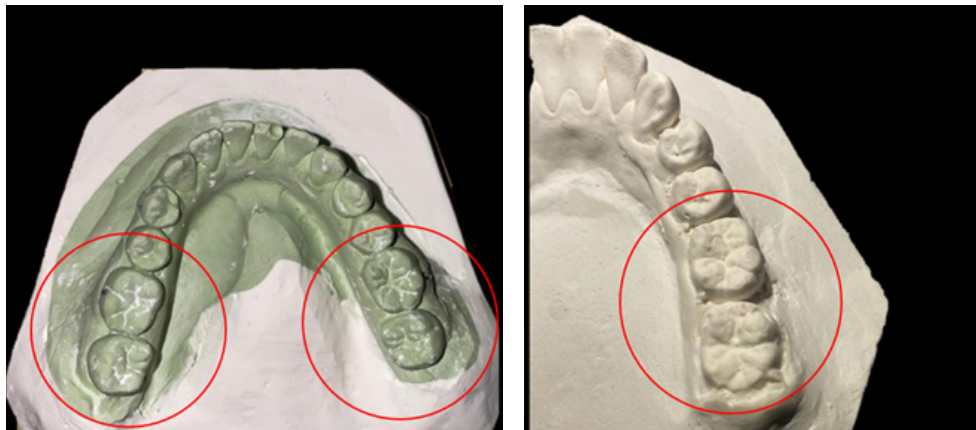


Figure 2. Illustration of “Y”, “+” and “X” groove patterns.⁷



A. Dryopithecus/ “Y” Pattern. **B.** Cruciform/ “+” Pattern. **C.** “X” Pattern

Figure 3. Stacked histograms showing number of cusps of mandibular molars based on ethnicity and gender.

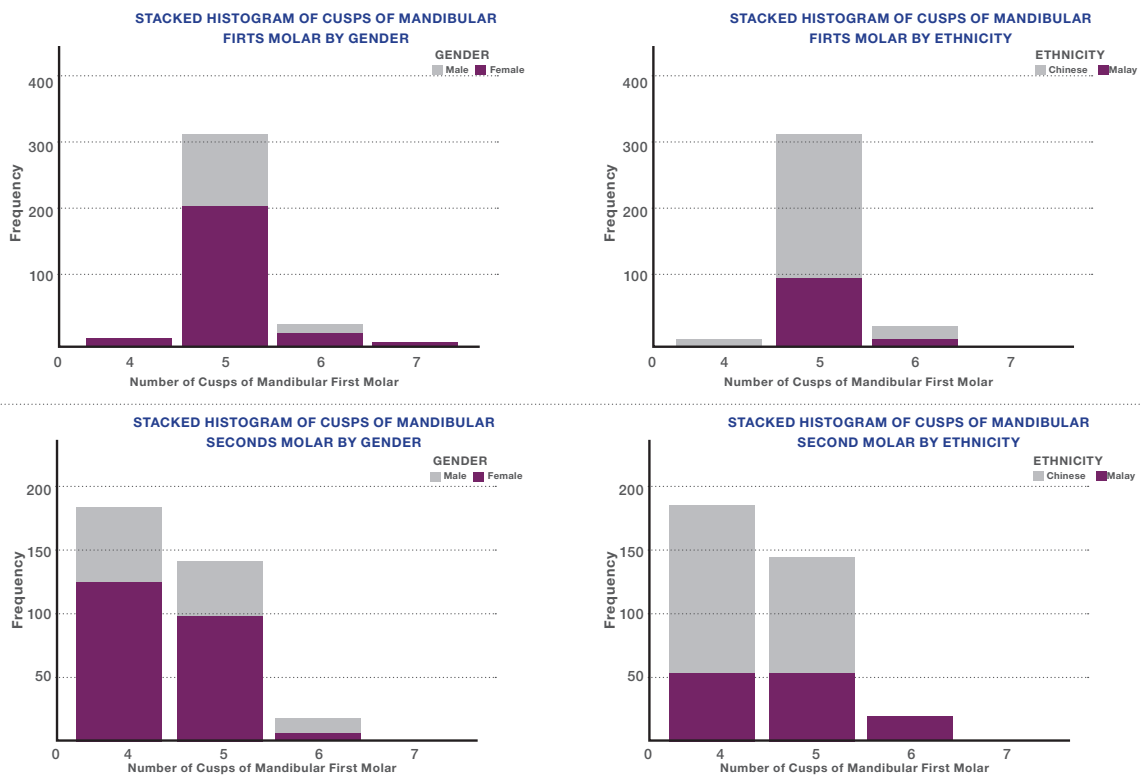


Figure 4. Stacked histograms showing groove patterns of mandibular molars based on gender and ethnicity.

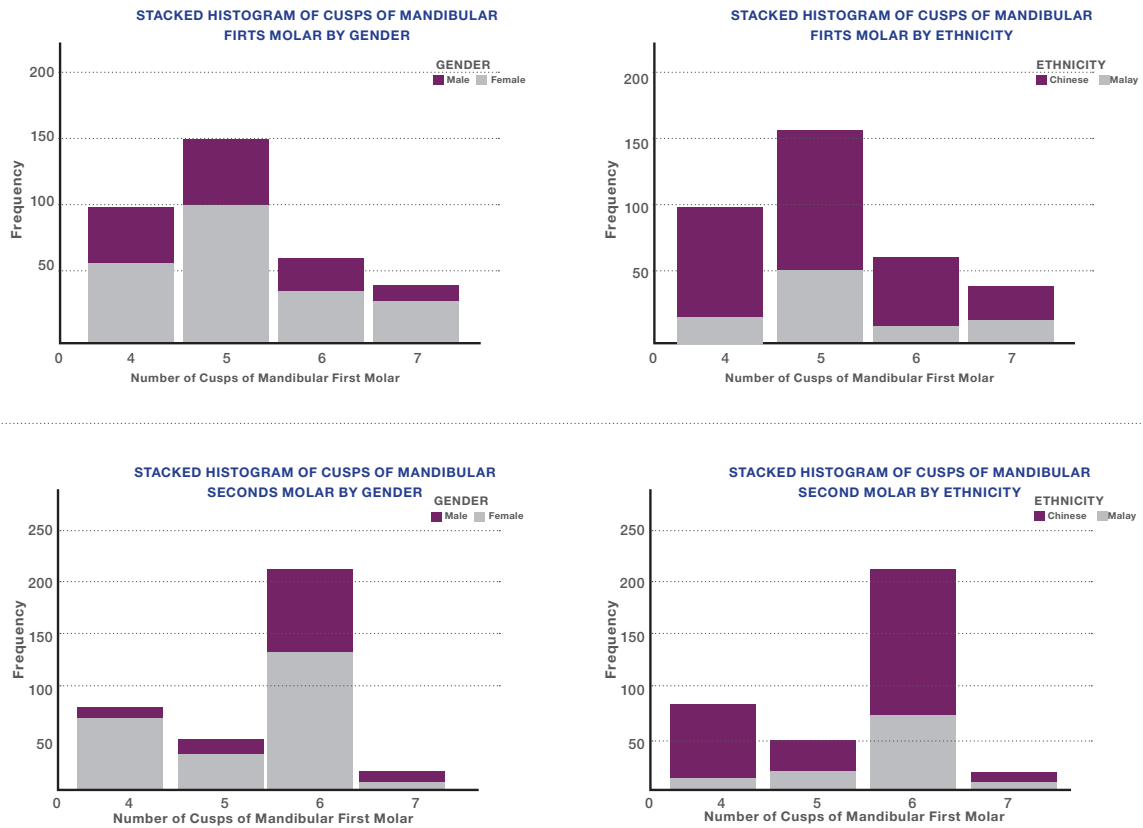


Figure 5. Clustered bar count chart of number of cusps of mandibular first molar by groove pattern.

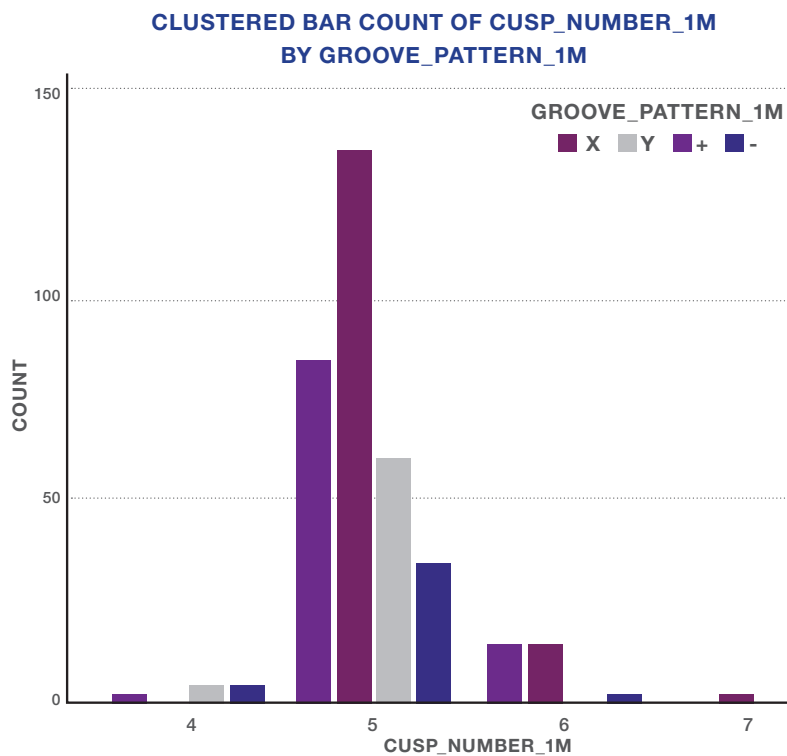
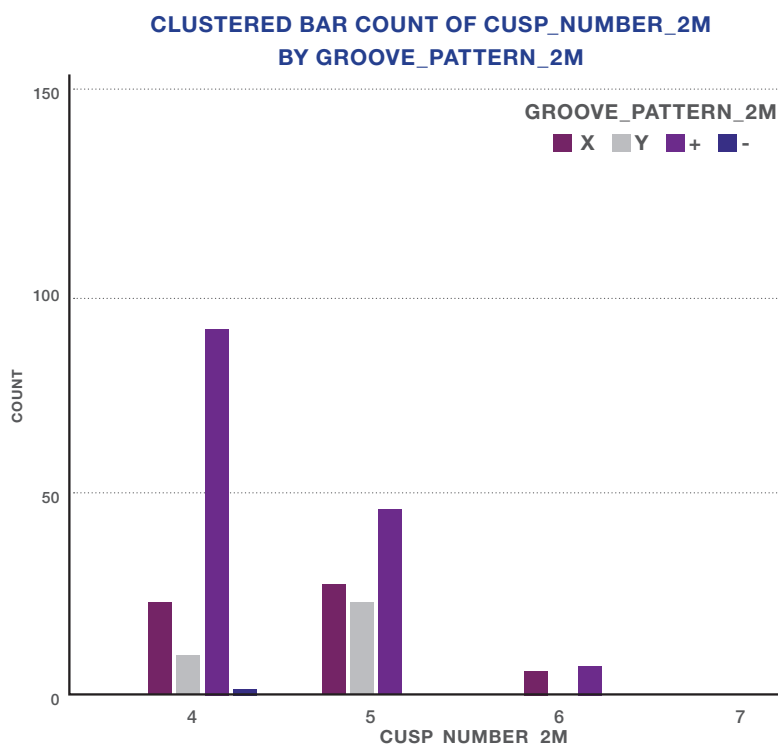


Figure 6. Clustered bar count chart of number of cusps of mandibular second molar by groove pattern



Bilateral symmetry of groove patterns

Patients in the present study displayed bilateral asymmetrical groove patterns. There was a significant difference in mandibular right first molar and mandibular left first molar ($p < 0.001$) where the more than 50% of the mandibular right first molar were “Y” pattern but the most prominent mandibular left first molar were “X” pattern (38.9%) (Table 1).

However, no similar observation was found for the mandibular second molars where most had ‘+’ groove pattern. There is no significant difference in mandibular right second molar and mandibular left second molar ($p = 0.878$).

Variations in number of cusps of mandibular first molar among gender and ethnicity groups.

There is no significant difference in mean of number of cusps of mandibular first molar

between male (mean = 5.09 ± 0.29) and female (mean = 5.05 ± 0.37) ($p = 0.067$), or between Chinese (mean = 5.07 ± 0.38) and Malays (mean = 5.06 ± 0.24) ($p = 0.853$). This indicated that the variation in number of cusps of mandibular first molar was not associated with gender and ethnicity (Figure 4).

Variation in number of cusps of mandibular second molar among gender or ethnicity groups.

There is no significant difference in the number of cusps of mandibular second molar between male (mean = 4.59 ± 0.68) and female (mean = 4.48 ± 0.55) ($p = 0.149$) or between Chinese (mean = 4.53 ± 0.63) and Malays (mean = 4.49 ± 0.50) ($p = 0.696$). This indicated that the variation in number of cusps of mandibular second molar was not associated by gender and ethnicity (Figure 4).

Variation in groove patterns of mandibular first molar among gender or ethnicity group

Variations in groove patterns of mandibular first molars were associated with ethnicity ($p=0.026$) but were not associated with gender ($p=0.336$). Significantly a higher proportion (50.0%) of Malays had groove patterns of “Y” compared to Chinese (38.7) (Table 1).

Variation in groove patterns of mandibular second molar due to gender or ethnicity

Variation in groove patterns of mandibular second molars was found to be associated with gender ($p=0.001$) and ethnicity ($p=0.013$). While the groove pattern “+” was prevalent among both Malays and Chinese, the Chinese exhibited a significantly greater prevalence of groove pattern “X” (27.4%) compared to Malays (12.5%). Additionally, when examining the groove patterns by gender, this study found that females had a significantly higher proportion (28.3%) of groove pattern “+” compared to male (11.7%) (Table 1).

Comparative assessment of the groove patterns and number of cusps.

The mandibular first molar most commonly has 5 cusps and the most common groove pattern is ‘Y’. From the diagram, groove pattern Y is not present when cusp number is less than 5. Groove pattern + is not present when cusp number increases beyond 5 cusps, and the other groove patterns are present throughout cusp number 4 to 6 (Figure 5).

The mandibular second molar most commonly has 4 cusps and the most common groove pattern is ‘+’. From the diagram, groove pattern “X” and “+” is present throughout when the number of cusps is 4 to 6, and groove pattern “Y” is not present when the number of cusps was more than 5 (Figure 5).

DISCUSSION

Teeth have important functions and have excellent postmortem preservation because they comprise the hardest tissues in the body. Understanding “*dental morphology (dental anatomy)*” is clinically necessary for dentists and oral hygienists. The application of this knowledge is in clinical dentistry (for diagnoses and treatment), forensic odontology (age, gender, race), dental anthropology (population genetics, environmental factors), archeology and paleontology.¹³ Even in comparative anatomy with genetically related orangutans, fossilized orangutan teeth can be distinguished from human teeth.^{14,15}

Dental casts were used as our study models because it was easier to visualize the cusps and groove patterns *in vitro* when compared to examining intra-orally.

Casts of young patients who sought orthodontic treatment (15-40 years old) were preferred as they have less damaged tooth structure due to caries, attrition, abrasion and erosion. Only Chinese and Malays were included in our study population because they are the two largest races in Malaysia of Mongoloid ancestry.

The present study shows that the most common number of cusps found in the mandibular first molar is 5 and with a ‘Y’ groove pattern. While in the mandibular second molar, the more common pattern is the 4-cusped molar with ‘+’ groove pattern. Hasund (1985)¹⁴ and Felemban and Manjunatha (1917)⁶ had similar findings as they noted a predominant pattern of “Y5” on lower first molars, and “+5” as well as “+4” on lower second molars in Inuit and Saudi population respectively. Loh¹⁶ (1991) explained that the predominance of four cusped

mandibular second molar is due to evolution, because the distobuccal cusp in a five cusped second molar almost always disappears. They further reiterated that the final tooth form represents the sum total of its genetic endowment and long-term environmental influences.

Scott and Turner (1997) demonstrated that most morphological dental traits had low sexual dimorphism but a strong symmetry, making them suitable for population characterization.⁷ Most of the examinations conducted in the present study revealed bilateral symmetry. However, a notable exception was found in the groove pattern of mandibular first molars, where sexual dimorphism was detected (Table 1).

A study conducted by Bunyarit (2017) stated that mandibular first molars had the greatest variation mesiodistally, and that the teeth size was generally larger in males compared in females.¹⁷ Alvesalo *et al.*,¹⁸ (1985) suggested that the difference in tooth size between the male and female is due to a differential growth-promoting effect of the Y chromosome which influences both enamel formation and possibly by cell proliferations, growth of dentine. This could be the reason that larger molar teeth have greater preponderance for “Y5” and also when 6 cusps were noticed.

Nevertheless, it is important to interpret the findings of this study with caution due to certain limitations that must be taken into consideration. For instance, the dental casts selected in this study were initially prepared for orthodontic patients. The accuracy and details were limited by the impression taker's

skill and properties of both impression and cast material. Alginate impression used in the study is known to have a higher tendency of distortion and is unable to record the fine details of occlusal tables unlike other impression materials such as silicone.

The reliability and accuracy of the data acquired could be improved in the future by using casts made from the rubber impression material and dental stone. It is worth mentioning that procedures of employing imaging modalities, image processing, and 3D reconstruction may assist in future dental morphology research.^{19,20}

Furthermore, to examine the variation among a wider population group, it is recommended to increase the sample size and include patients from different regions of the country.

CONCLUSION

In summary, the mandibular first molar with 5 cusps and groove pattern ‘Y’ while the mandibular second molar with 4 cusps and groove pattern ‘+’ were found to be the most common tooth morphology in our study population. This study demonstrated the association of groove patterns and gender and ethnicity which is valuable knowledge that could be applied in gender and ethnicity identification.

CONFLICT OF INTERESTS

The authors of this manuscript certify that they have no conflict of interest.

ETHICS APPROVAL

This study was approved by the Medical Ethics Committee of the Faculty of Dentistry, MAHSA University.

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AUTHORS' CONTRIBUTIONS

Calvin Jia Jun: writing original draft, investigation.

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Prathap Chander Manivannan: Supervision, conceptualization, review manuscript.

Wong Gou Rean: data analysis, result validation, review and editing manuscript.

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