Cephalometric and Malocclusion Analysis of Kadazan Dusun Ethnic Orthodontic Patients
(Analisis Sefalometrik dan Maloklusi Pesakit Ortodontik Etnik Kadazan Dusun)

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ABSTRACT

The aims of this study were to assess the skeletal pattern and the malocclusion of Kadazan Dusun ethnic patients who seek for orthodontic treatment. Cephalometric radiographs (248) and 345 study models were collected from four orthodontic clinics in Sabah. The cephalometric mean values (SNA, SNB, ANB, MMA, SNMxP, UIMxP, LIMnP and ALFH) were measured and the study models were analysed for overjet, overbite, incisor and molar relationships. Some morphological or occlusal features such as shovel shape, Talon cusp, peg shape teeth, midline diastema, canine displacement and supernumerary tooth were also noted. The frequency and correlation of cephalometric mean values and prevalence of malocclusion were analysed using SPSS 18. Class I Skeletal pattern was the most common (48%) followed by Class II (33%) and Class III (18%). There was a strong correlation between SNA and SNB values (>0.70). Class II/1 incisor relationship has the highest frequency (41%) followed by Class III (32%), Class I (21%) and Class II/2 (6%). Class II Molar relationship of both right and left showed highest frequency (38%) followed by Class I (33%) and Class III (30%). Increased of overjet (44%) and reduced overbite (41%) and shovel-shaped incisor were the most common occlusal and dental features. The Kadazan Dusun patients who seek for orthodontic treatment in Sabah were mostly presented with Class I Skeletal pattern with high prevalence in Class II/1 incisor relationship, Class II molar relationship, increased overjet and reduced overbite. The orthodontic treatment pertaining to this ethnicity should be in line with the findings that will benefit patient specifically based on their common presented features.

Keywords: Cephalometric; Kadazan Dusun; malocclusion; orthodontic treatment

ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji corak pola rangka dan kelaziman maloklusi pada pesakit Kadazan Dusun yang mendapatkan rawatan ortodontik. Radiograf sefalometrik (248) dan 345 model kajian telah dikumpulkan daripada empat klinik ortodontik di Sabah. Nilai purata sefalometrik (SNA, SNB, ANB, MMA, SNMxP, UIMxP, LIMnP dan ALFH) telah diukur dan model kajian telah dianalisis untuk melihat hubungan antara 'overjet', 'overbite', perhubungan insisor dan molar. Beberapa morfologi atau ciri-ciri oklusi seperti gigi bentuk penyodok, kuspa talon, gigi berbentuk pasak, diastema garis tengah, peralihan gigi taring dan lebihan bilangan gigi dicatatkan. Frekuensi dan perkaitan antara nilai purata sefalometrik dan kelaziman maloklusi dianalisis menggunakan SPSS 18. Corak Skeletal Kelas I (48%) adalah yang paling biasa diikuti oleh Kelas II (33%) dan Kelas III (18%). Terdapat perkaitan yang kuat antara nilai SNA dan SNB (>0.70). Perhubungan incisor Kelas II/1 menunjukkan frekuensi yang tertinggi (41%) diikuti oleh Kelas III (32%), Kelas I (21%) dan Kelas II/2 (6%). Perhubungan molar Kelas II pada kanan dan kiri menunjukkan frekuensi yang tertinggi (38%) diikuti oleh Kelas I (33%) dan Kelas III (30%). Peningkatan 'overjet' (44%), pengurangan 'overbite' (41%) dan insisor berbentuk penyodok adalah ciri-ciri gigi dan oklusi yang lazim. Pesakit ortodontik Kadazan Dusun Sabah kebanyakannya menunjukkan corak pola rangka Kelas I dengan kelaziman yang tinggi pada perhubungan insisor Kelas II/1, perhubungan molar Kelas II, peningkatan 'overjet' dan penurunan 'overbite'. Rawatan ortodontik untuk etnik ini perlu selaras dengan penemuan kajian ini dengan pesakit boleh mendapat faedah khususnya berdasarkan kepada ciri-ciri am mereka.

Kata kunci: Kadazan Dusun; maloklusi; rawatan ortodontik; sefalometrik

INTRODUCTION

Kadazan Dusun is the predominant ethnic group in Sabah (Department of Statistic Malaysia 2001). Although the tale of origin of this ethnic group is still a big question mark of when and how they arrived, but according to a study done by Owen Rutter suggested that this population originated from the Mongoloid race that reached Borneo or Brunei from Indochina through Philippines or came directly from the mainland of Asia (Hose & McDougall 1912). Meanwhile, according to Lee (1930), the Proto-Malay group has many similarities with the people on the Island of Borneo in the aspects of physical, culture as well as languages.

There have been many studies conducted to determine the craniofacial morphology and prevalence of malocclusion in many different races. Analysis of craniofacial morphology is an essential tool in orthodontic evaluation and clinical treatment, where it provides information that enables the classification of the skeletal as well as dental anomalies (Susanti Munandar 1992). Classification of the occlusion, on the other hand is one of the first steps in diagnosing the relationship between the upper and lower teeth (occlusion) and it is used in evaluation of orthodontics treatment (Angle 1900).

The facial skeleton is known to be influenced by both genetic and environmental factors. However, the effect of the environmental factors toward the growth can depend upon how tightly growth is under genetic control. It is undoubtedly that genetic control has a significant influence in facial growth and the effect is more on the anterior-posterior facial form than vertical facial form. The vertical growth can be influenced by three main possible environmental factors which are mouth breathing, soft tissue stretching and the structure/function of muscle of mastication (Mitchell 2007).

Malocclusion, on the other hand, is not a disease but one end of the spectrum of normal variation. Research suggested that the etiology of the majority of malocclusion is multi-factorial. It can be due to genetically determined factors or environmental factors. Commonly it is a combination of both inherited and environmental factors together. It can be recorded qualitatively and quantitatively. The two well-known classifications of malocclusion are the Angle and British Standard Institute (BSI) classifications of incisor relationship (Mitchell 2007).

Studies on craniofacial relations and variations in man have long been used to differentiate various racial groups in physical anthropology. Morphological features of different races and ethnic groups are not randomly distributed but appear in geographic clusters (Argyropoulos & Sassouni 1989). However, there is still no study undertaken regarding the cephalometric morphology and dento-alveolar variation among the Kadazan Dusun population.

MATERIALS AND METHODS

SAMPLE SELECTION

This study was a retrospective study of record reviews of the lateral cephalometric radiographs and study models from the year 1998 to early of 2010. The samples were selected through a non-probability convenience sampling procedures from two government dental clinics (Luyang Hospital Dental Clinics and Sandakan Hospital Dental Clinics) and from two private orthodontic clinics (Smile Orthodontic Clinic and Damai Dental Clinics) in Sabah where there are availability of orthodontic treatment that provides access to lateral cephalometric radiograph and study model for target groups. In this study, the samples were selected on an ad-hoc basis.

The nature of this sampling procedure does not permit the generalization of the findings to the Kadazan Dusun population at large.

In total, there were about 760 Kadazan Dusun patients who have attended the orthodontic dental clinics from 1998 to early of 2010, including those who were in the waiting lists. The inclusion and the exclusion criteria in the data collection for cephalometric analysis as well as malocclusion, however, had reduced the sample size. The inclusion criteria were both parents are from Kadazan Dusun ethnicity from particulars in the patients' folder and no history of orthodontic treatment. The exclusion criteria were cleft lip and palate or other cranio-facial disorders, poor quality radiographs (for cephalometric analysis) and broken study model that affects the tooth/teeth of interest (for malocclusion analysis). The ethical approval for the study was obtained from the Research and Ethical Committee, Universiti Kebangsaan Malaysia.

CALIBRATION

The training and calibration of measurements of lateral cephalometric radiograph and study model were done before data collection started, where the examiners were calibrated under supervision of the supervisor and orthodontist as a gold standard. Fifteen lateral cephalometric radiographs were traced and retraced after two weeks while 20 study models of patient received orthodontic treatment were examined by each investigator to assess for inter-examiner reliability.

SAMPLE EXAMINATION

The method of this study is divided into two major parts, first, assessment of the skeletal pattern by analyzing the lateral cephalometric radiographs and second, assessment of the malocclusion of the samples by analyzing the study models.

THE SKELETAL PATTERN

The skeletal pattern relationship among Kadazan Dusun sample was determined from the patient's lateral cephalometric radiographs tracing manually using a grid acetate paper that was superimposed on the radiograph. The tracing was carried out in a darkened room using a light viewing box to get a clear view of the various landmarks. The presence of excess light around the area being traced was blocked out using black paper with a rectangular hole. In order to facilitate landmark's identifications, the best medium, the proprietary acetate sheet is used. The acetate was oriented in the same position as the patient when the radiograph was taken and it is secured onto the film using a tape. The landmarks were then marked with a sharp mechanical pencil.

The anterior-posterior relationship and facial vertical dimensions of the patient were evaluated by measuring the angle between various cephalometric landmarks. The cephalometric landmarks such as cephalometric points,

cephalometric line/planes, angles and linear measurements were determined by using the Eastman standard mean values, a cephalometric normative mean values for Caucasian (Chung et al. 2000). The cephalometric analysis to measure the antero-posterior relationship of the maxilla and mandible are shown in Table 1.

The Dental/Occlusion Features   The features of malocclusion were analyzed using study models. The features that took into account in this research were the incisor relationship, molar relationship, overjet and overbite from upper and lower canine to canine. A metal ruler was used to measure the overjet and overbite. Other features such as a shovel or peg shape tooth, Talon cusp, midline diastema, canine displacement and supernumerary tooth were also noted.

STATISTICAL ANALYSIS

The data were analyzed using the Statistical Package for Social Science (SPSS) programme version 18.0. A descriptive statistics (frequency and percentage) were determined. The Pearson's correlation coefficient (r) was used to measure the association between two numerical variables in the cephalometric parameters where $p<0.05$ is considered as statistically significant difference.

RESULTS

CALIBRATION

For the calibration, the Kappa values of 0.714 (tracing) and 0.878 (study model) among the inter-examiners were found, respectively. There was a good agreement among the examiners. The kappa value between the intra-examiner for study model had a good agreement with the golden standard with value of 0.745 and 0.787.

DEMOGRAPHIC DATA

The demographic features such as gender and age range were also observed. For age range, children and adolescence samples that were 17 years old and below were categorized as R1 and the adult samples that were 18 years old and above were categorized as R2 (Table 2). Based on gender, there was a higher percentage in female samples compared with male samples, whereas, based on age range, there was a higher percentage in R1 samples compared with R2 samples (Table 2).

CEPHALOMETRIC ANALYSIS DATA

Admittedly, some radiographs were not in good quality and only 248 can be analyzed out of 345 radiographs. The normative cephalometric values for Kadazan Dusun

TABLE 1. Cephalometric analysis to measure the antero-posterior relationship of the maxilla and mandible

	Angle	Mean value ± standard deviation
SNA:	Angle that indicates the position of maxilla to the cranial base	81° ± 3°
SNB:	Angle that indicates the position of mandible to the cranial base	78° ± 3°
ANB:	Angle that indicates the relative position of maxilla and mandible antero-posteriorly	3° ± 2°
MMA:	Angle that indicates the relative position of maxilla and mandible vertically	27° ± 4°
SNMxP:	Angle between SN plane and Maxillary plane	8⁰ ± 3°
LiMnP:	Angle of the lower incisor inclination to the mandibular plane	93° ± 6°
UiMxP:	Angle of the upper incisor inclination to the maxillary plane	109° ± 6°
LAFH:	Lower anterior facial height	55% ± 2%

TABLE 2. Demographic data of Kadazan Dusun patients in cephalometric analysis and study model analysis

Demographic analysis	Cephalometric analysis (n=248)	Study model analysis (n=345)
	n (%)	
Gender	72(29.0)	93(27.0)
Male	176(71.0)	248(71.9
Female	-	4(1.2)
Missing value		
Age		
R1: 9-17 years old	156(62.9)	205(59.4)
R2: ≥18 years old	92(37.1)	123(35.7)
Missing value	-	17(4.9)

population were assessed according to the Eastman Standard value.

Maxillary Skeletal Relationship It was shown that there were highest percentage of samples with average maxilla, followed by a prognathic maxilla and a retrognathic maxilla (Table 3).

Mandibular Skeletal Relationship It was shown that half of the total samples have an average mandible, followed by samples with prognatic mandible and samples with retrognathic mandible (Table 3).

Intermaxillary Relationship It was shown that almost half of the total samples had Class I Skeletal pattern, followed by Class II skeletal pattern and Class III skeletal pattern (Table 3).

Vertical Dimension It was shown that more than half of the total samples have an average vertical dimension, followed by an increased vertical dimension and reduced vertical dimension. Based on age range and gender, the similar

trend could be seen in both male and female samples and both R1 and R2 groups (Table 3).

Dento-alveolar Relationships It was shown that almost half of the total sample had an average inclination of the lower incisor, followed with proclined lower incisors and retroclined lower incisors. Based on gender and age range, the similar trend could be seen in female samples. However, the males had the highest percentage of proclined lower incisors followed by average inclination of lower incisors and retroclined lower incisors (Table 3).

Upper Incisor Inclination It was shown that there was highest percentage of samples with proclined upper incisor, followed by average inclination of upper incisors and retroclined upper incisors. The similar trend could also be seen based on demographic distribution (Table 3).

Correlation Test between Cephalometric Values The Pearson's correlation coefficient (r) was used to measure the association between two variables in the cephalometric parameters. There was a significantly positive association

TABLE 3. Frequency of Cephalometric parameter based on total samples and demographic distribution of Kadazan Dusun patients

Cephalometric parameters	Total sample n (%)	Age range n (%)		Gender n (%)	
	n=248	R1 n=156	R2 n=92	Male n=72	Female n=176
Sagittal plane					
Class I	121(48.8)	76(48.7)	45(49.0)	39(54.2)	82(46.6)
Class II	82(33.1)	53(34.0)	29(31.5)	21(29.2)	61(34.6)
Class III	45(18.1)	27(17.3)	18(19.5)	12(16.6)	33(18.8)
Vertical dimension					
Average	153(61.7)	104(66.7)	49 (53.3)	43(59.7)	110(62.5)
Increased	53(21.4)	29(18.6)	24(26.1)	17(23.6)	36(20.5)
Reduced	42(16.9)	23(14.7)	19(20.6)	12(16.7)	30(17.0)
Maxillary skeletal relationship					
Average	141(56.9)	86(55.1)	55(59.8)	46(63.9)	95(54.0)
Prognathic	77(31.0)	51(32.7)	26(28.2)	17(23.6)	60(34.1)
Retrognathic	30(12.1)	19(12.2)	11(12.0)	9(12.5)	21(11.9)
Mandibular skeletal relationship					
Average	139(56.0)	93(59.6)	46(50.0)	44(61.1)	95(54.0)
Prognathic	67(27.1)	38(24.4)	29(31.5)	15(20.8)	52(29.5)
Retrognathic	42(16.9)	25(16.0)	17(18.5)	13(18.1)	29(16.5)
Dento-alveolar relationship					
Lower incisor inclination:					
Average	108(43.5)	68(43.6)	40(43.5)	28(38.9)	80(45.4)
Proclined	98(39.5)	61(39.1)	37(40.2)	35(48.6)	63(35.8)
Retroclined	42(19.0)	27(17.3)	15 (16.3)	9(12.5)	33(18.8)
Upper incisor inclination:					
Average	49(19.8)	29(18.6)	20(21.7)	13(19.0)	36(20.5)
Proclined	194(78.2)	126(80.8)	68(73.9)	58(80.0)	136(77.2)
Retroclined	5(2.0)	1(0.6)	4(4.3)	1(1.0)	4(2.3)

R1: Age group below 17 years old; R2: Age group 18 years old and above

(r=0.698) between the SNA and SNB angle values of cephalometric parameters among Kadazan Dusun patients (p<0.05). There were also a significant positive association (p<0.05) between SNA and ANB, LiMnP, UiMxP and LAFH; between SNB and LiMnP, UiMxP and LAFH; between ANB and MMA, SNMxP and LiMnP; between MMA and LiMnP; between LiMnP and UiMxP. There were significantly negative associations (p<0.05) between SNA and MMA, SNMxP; between SNB and ANB, MMA, SNMxP; between ANB and UiMxP and LAFH; between SNMxP and LiMnP, UiMxP and LAFH; between MMA and UiMxP and LAFH; between LiMnP and LAFH; between UiMxP and LAFH. (Table 4).

STUDY MODEL ANALYSIS

Incisor Relationship A total of 345 models were analyzed for the dental occlusal features. Class II division 1 incisor relationship show the highest percentage followed by Class III incisor relationship, Class I incisor relationship and Class II division 2 incisor relationship. Based on demographic distribution, the R1 group and both gender showed the similar trend. The R2 group, however, had the highest percentage with Class III incisor relationship followed by Class II division I incisor relationship, Class I incisor relationship and Class II division 2 incisor relationship (Table 5).

Molar Relationship The molar relationship was divided into the left side and right side of molar relationships. On the left side molar relationship, the highest percentage was found in samples with Class II molar relationship followed by both Class I molar relationship and Class III molar relationship. Based on demographic distribution, the similar trend was found in the R2 group. Both the R1 and female samples showed the highest percentage in Class II molar relationship, followed by Class I molar relationship and Class III molar relationship. In the male samples, the highest percentage was Class II followed with Class III molar relationship and Class I molar relationship. Meanwhile, on right side of molar relationship, the highest percentage was Class II molar relationship followed by

Class I molar relationship and Class III molar relationship. Based on demographic distribution, the similar trend was seen in both gender and both age ranges. When the left side of the molar relationship was compared with the right side of molar relationship of each sample, more than half of the total samples were found to have a symmetrical molar relationship (Table 5).

Overjet and Overbite Values In total, the highest percentage was found in sample with increased overjet value of more than 4 mm followed by samples with normal overjet value within the range of 2 mm to 4 mm and the samples with decreased overjet value of less than 2 mm. On the other hand for the overbite, the highest percentage with reduced overbite (less than 30%) followed by increased overbite (more than 30%) and normal overbite (30%) (Table 6).

Other Dental Features There were several dental features found among the collected samples which were shovel shaped of the upper incisor, displaced canines, midline diastema, supernumerary teeth lateral peg and Talon cusp of the lateral incisor (Table 7). Most of the samples have shovel of the upper incisors (77.1%).

DISCUSSION

This retrospective study of record reviews was conducted to determine the most common skeletal pattern and the prevalence of malocclusion among the Kadazan Dusun orthodontic patients. The highest percentage in Class I skeletal pattern was shown to be similar to Deutero-Malay Indonesian through a study conducted by Susanti Munandar (1992) who had also used the Eastman Standard Mean value to classify the cephalometric morphology of their population. Another interesting finding was the existence of correlation between SNA and SNB values that had a significantly strong positive correlation. The ANB was obtained due to the resultant morphology and size variation in various components in the craniofacial structures that in turned influenced by the genetic factor and thus, could

TABLE 4. Pearson's correlation coefficient (r) of cephalometric parameters in Kadazan Dusun patients

Cephalometric parameters	SNA	SNB	ANB	SNMxP	MMA	LiMnP	UiMxP	LAFH
SNA	1	0.698*	0.246*	-0.160*	-0.474*	0.173*	0.135*	0.214*
SNB	0.698*	1	-0.274*	-0.318*	-0.476*	0.130*	0.182*	0.306*
ANB	0.246*	-0.274*	1	0.159*	0.039	0.206*	-0.049	-0.033
MMA	-0.474*	-0.476*	0.039	-0.198*	1	0.22	0.115	-0.301*
SNMxP	-0.160*	-0.318*	0.159*	1	-0.198*	-0.392*	-0.386*	-0.367*
LiMnP	0.173*	0.130*	0.206*	-0.392*	0.022	1	0.247*	-0.151*
UiMxP	0.135*	0.182*	-0.049	-0.386*	-0.115	0.247*	1	-0.141*
LAFH	0.214*	0.306*	-0.033	-0.367*	-0.367*	-0.151*	-0.141*	1

* Correlation is significant at p< 0.05

TABLE 5. Occlusion relationship of the study model based on total samples and demographic
distribution of Kadazan Dusun patients

Relationship	Total sample n (%)	Gender n (%)		Age n (%)	
	n=345	Male n=93	Female n=248	R1 n=205	R2 n=123
Incisor					
Class I	71(20.6)	19(20.4)	51(20.6)	42(20.5)	25(20.3)
Class II/1	141(40.9)	44 (47.3)	95(38.3)	98(47.8)	38(30.9)
Class II/2	22(6.4)	5(5.4)	17(6.9)	11(5.4)	10(8.1)
Class III	111(32.2)	25(26.9)	85(34.3)	54(26.3)	50(40.7)
Missing value(s)	-	-	-	-	-
Molar-left					
Class I	109(31.6)	25(26.9)	81(32.7)	66(32.2)	37(30.1)
Class II	126(36.5)	37(39.8)	89(35.9)	73(35.6)	49(39.8)
Class III	109(31.6)	31(33.3)	77(31.0)	65(31.7)	37((30.1)
Missing value(s)	1(0.3)		1(0.4)	1(0.5)	-
Molar-right					
Class I	112(32.5)	31(33.3)	80(32.3)	66(32.2)	40(32.5)
Class II	135(39.1)	37(39.8)	97(39.1)	77(37.6)	53(43.1)
Class III	97(28.1)	25(26.9)	70(28.2)	61(29.8)	30(24.4)
Missing value(s)	1(0.3)		1(0.4)	1(0.5)	-
Molar symmetry					
Symmetrical	231(67.0)	-	-	-	-
Asymmetrical	112(32.5)	-	-	-	-
Missing value(s)	1(0.3)	-	-	-	-

R1: Age group below 17 years old; R2: Age group above 18 years old

TABLE 6. Frequency of overjet and overbite value of Kadazan Dusun
patients (n=345)

Variables		n (%)
Overjet value		
	Normal (2-4mm)	109 (31.6)
	Increased (>4mm)	150 (43.5)
	Decreased (< 2 mm)	86 (24.9)
Overbite value		
	Normal (30%)	71 (20.6)
	Increased (>30%)	133 (38.6)
	Decreased (<30%)	141(40.9)
	Total	345 (100)

TABLE 7. Frequency of other dental features of
Kadazan Dusun patients

Dental features	n (%)
Shovel incisor	266 (77.1)
Talons cusp	3 (0.9)
Lateral peg	8 (2.3
Displace canine	110 (31.9)
Supernumerary teeth	8 (2.3)
Midline diastema	12 (3.5)

differ from one race to another in a different geographic cluster (Mehta & Gupta 2008). EL-Batran et al. (2008), in his study about the relationship between the cranial base and maxillofacial morphology in Egyptian children found that instead of the correlation between the SNA and SNB, it was the relationship between the SNB and ANB that correlate strongly in their sample. Meanwhile, our study found there was a significant positive correlation between the SNA and SNB. Therefore, the significant strong positive correlation between the SNA and SNB in our study was the reflection of higher percentage in average maxilla, higher percentage of the average mandible with the resultant

higher percentage in Class I skeletal pattern in Kadazan Dusun orthodontic patients.

Our result revealed the highest percentage in sample with Class II division 1 incisor relationship, which was about 40.9% of the total sample and there was no difference in trend based on gender and age range. It was also supported by Gelgör et al. (2007) that reported Class II division 1 malocclusion was the most prevalent occlusal pattern among the population study. It also stated that a higher percentage of increased overjet (25.1%) and increased overbite (18.3%) were a reflection of the high prevalence of Class II malocclusion.

Our present study also revealed a high percentage of increased overjet value and increased overbite that could support the suggestion about the reflection of the overjet value toward the highest percentage of Class II division 1 incisor relationship among the Kadazan Dusun patients. Our result however, had shown that instead of increased overbite, the highest percentage among the Kadazan Dusun patients was found with a reduced overbite. Adam and Kerr (1981) revealed that there was a negative correlation between the facial height and overbite, which indicated that the overbite value is not solely influenced by the type of malocclusion, but it can also be influenced by the facial height of an individual. Apart from that, both left and right side molar relationship exhibited the highest percentage in a sample with class II molar relationship, whereby the left side molar relationship was 36.5% and right side molar relationship was 39.1% and there was no difference in trend based on demographic distribution. Huang et al. (2002) found that the prevalence for class II molar relationship among Chinese population in China was 2.64%. Meanwhile, Sim (1972) found that the prevalence of Class II molar relationship in the United States, was 35%. The assessment of molar symmetry in our study revealed that in total, samples with symmetrical molar relationship and asymetrical molar relationship were 67.2% and 32.5%, respectively. According to Angle (1899, 1900) and Garner and Butt (1985), the prevalence of asymetrical molar relationship among the white population was as low as 4.6%. Woon et al. (1989) found that among the Malay and Chinese populations, there were increased in prevalence of asymetrical molar relationship, which were 28% and 23%, respectively. The results for molar and incisor relationship from this study, however, were not representative of the Kadazan Dusun population because the evaluation was only done on samples who seek for orthodontic treatment. Therefore, it was not surprising that most samples had occlusion, which deviated from the ideal occlusion.

Another interesting finding was that the most common dental feature observed was shovel shaped of the upper incisor with a percentage of 77.1%. Shovel trait is a combination of a concave lingual surface and elevated marginal ridges enclosing a central fossa in the upper central incisor teeth. Dahlberg (1951) and Hanihara (1968) reported that a high frequency of shovel shaped incisor was commonly found in Mongoloid dental complex. The literature showed that Chinese and Caucasoid population had a remarkably different frequency in the expression of shovel trait on the upper right central incisor teeth. As a consequence, shovel trait has been regarded as dental markers of Chinese and Caucasoid ancestry (Hrdliucka 1920; Lee & Goose 1972; Mayhall et al. 1982; Townsend & Martin 1992; Townsend et al. 1990).

The present study provides an insight for the establishment of the cephalometric normative mean values for the Kadazan Dusun population in the future, by using a sample with normal occlusion. With the establishment of the cephalometric normative mean value, a comprehensive diagnosis of malocclusion among the Kadazan Dusun patients can be more accurate and it provided a basis of reference for orthodontic treatment like a patient who needs orthognathic surgery.

CONCLUSION

The most common type of skeletal pattern in Kadazan Dusun patients who seek for orthodontic treatment in Sabah were Class I skeletal pattern with average maxilla and average mandible among the Kadazan Dusun patients. The highest prevalence of malocclusion in Kadazan Dusun patients who seek for orthodontic treatment in Sabah was Class II division 1 Incisor Relationship, Class II molar relationship, increased overjet and reduced overbite. The most common dental feature seen was shovel shaped incisor.

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