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Evaluation of Dental and Basal ArchForm among Patients Seeking Orthodontic Treatment

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ABSTRACT

Aims and Objectives: The objectives of the present study were to evaluate the nature of arch form among patients seeking orthodontic treatment in Nepalese population and the morphological differences in the arch form present in different classes of Angle's malocclusions.

Materials and Methods: One hundred and three dental casts were obtained from the records of patients who sought orthodontic treatment. Six parameters intercanine width at the facial axis point (ICFA),intercanine width at the WALA ridge point(ICWR),intermolar width at the facial axis point(IMFA),intermolar width at the WALA ridge point(IMWR), arch form atthe facial axis point (AFFA) and arch form atthe WALA ridge point (AFWR) were used. In each tooth, from the left first molar to the right first molar, a glass bead was glued to simulate the ideal position of an orthodontic bracket. All beads were initially measured with a digital caliper-Shan. Each glass bead (1.5mm) was positioned in the centre of the clinical crown of the incisors, canines, and premolars, and in the middle third of the mesiobuccal cusps in the first molars. Then, glass beads of 2mm were glued and positioned on the anatomic line of the WALA ridge. A clear piece of glass slab of 2mm thickness was placed over the model to gain a stable platform for 100micron thick polyester film. The bead positions were transferred on polyester sheet with a permanent marking pen to simulate 12 clinical bracket points and corresponding WALA ridge points. These points were joined. The arch forms, thus obtained were classified into square, ovoid or tapered with the help ofOrthoform™ diagnostic arch form templates. ANOVA test,the Pearson Correlation test andChi square test were used to assess the correlation between the variables at P-value of 0.05 using SPSS version 11.5.

Results: Statistically significant association was found between AFFA and AFWR. Square and ovoid arch forms were more prevalent among all classes of malocclusion. No statistically significant difference was found within and between the group for ICFA, ICWR and IMFA, whereas, significant difference was found with respect to IMWR. Class III showed the highest value for IMWR followed by class II and class I.

Conclusions: Arch form determined at FA point (AFFA) can be reliably used to determine individual arch form.

Key Words: Angle's classes of malocclusion, Arch form, Facial axis, WALA point

INTRODUCTION

Relapse is a major concern in today's orthodontic practice. It has been shown in animal studies that relapse commences immediately after teeth are left unrestrained[1].Understanding the relationship between dental and basal arch form is of diagnostic and therapeutic importance because the dental arch cannot be expanded beyond a limit. Periodontal complications and increased risk of relapse may be expected if the teeth are moved beyond the limit of the apical base, especially in the mandibular arch.

Stability is a goal of orthodontic treatment, but there are many views on which method of treatment will produce the most stable result.Tweed, Nance and Brodie all agreed that stability is related to basal bone[2-4].Strang argued that intercanine width was key to stability[5].Maintaining the patient's pre-treatment arch form has been suggested by some practitioners as a key to achieve stable orthodontic results[6].Keeping the patient's arch form while correcting the teeth might make the end result less likely to relapse[7].Several authors believe that stability relates to keeping the original arch form while maintaining the teeth over the basal bone[2,4,5,].There is a limit to the change in posterior width, and particularly intercanine width, that can be achieved and remain stable. Ball et al. argued that there is a difference inintercanine width between dental and basal arches but that it was unlikely to affect the arch form as it was only 0.8 mm[8]. Several studies have examined the characteristics of dental arch form in different ethnic group[9-11].Some previous studies were aimed at finding mathematical relations to describe the dental arch. The reference points used for the measurements in these studies were incisal edges and cusp tips[12-15].However, these landmarks do not represent the clinical archwire form. Few studies have been performed on the shape of the basal arch[8,16,17].However, basal bone has been difficult to define so, there is no one method of treatment that will ensure stability.

The application of a single ideal arch form to every member of an ethnic group, despite individual variations adversely affect post-treatment occlusal stability[18,19].The arch form varies according to malocclusion and population under study[11].Thereforethe present study was conducted to evaluate the type of the arch form among patients seeking orthodontic treatment in Nepalese population and to evaluate the morphological differences in the arch form present in different classes of Angle's malocclusions.

MATERIALS AND METHODS

A cross-sectional study was conducted from August 2016 to July 2017among one hundred three dental casts of patients seeking orthodontic treatment in Orthodontics and DentofacialOrthopaedic Unit, Department of Dentistry, Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu, Nepal.Ethical clearance was obtained from the Institutional Review Board, Institute of Medicine [166(6-11-E)2/073/074]. The samples were divided into three groups based on Angle's classification of malocclusion, namely, Group 1- Angle's Class I malocclusion, Group 2- Angle's class II malocclusion and Group 3- Angle's class III malocclusion.For determination of correlation between dental arch form and basal arch form, six parameters, namely, intercanine width at FA point (ICFA), intercanine width at the WALA point (ICWR), intermolar width at FA point (IMFA), intermolar width at the WALA point (IMWR), arch form at FA (AFFA) and arch form at the WALA point (AFWR) were used.

Study model landmarks: Facial-Axis of the Clinical Crown (FACC) was defined as the most prominent portion of the central lobe of the facial surface of all teeth crowns, except for the molars, which corresponds to the groove that separates the two large facial cusps.WALA Ridge was defined as soft tissue ridge located below the gingival margins of mandibular tooth crowns and immediately above the mucogingival junction.Facial-Axis Point (FA point) was defined as a point on FACC that separates the gingival half of the clinical crown from the occlusal half**(Figure 1)**.

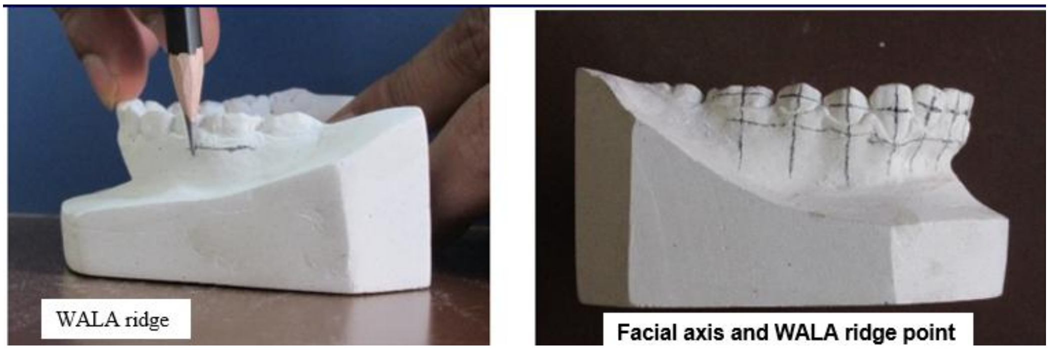

Figure 1: Delineation of WALA ridge, Facial axis and WALA ridge point

Delineation and measurements of landmarks: The most prominent point on the curve of the WALA ridge adjacent to each tooth was denominated WALA Ridge Point (Point WR).Intercanine width at FA point (ICFA)was the distance between the mandibular right and left canines on the respective FA points.Intermolar width at FA point (IMFA) was the distance between the mandibular right and left canines on the respective FA points.Intercanine width at WALA ridge (ICWR) was a transverse dimension between the points of the WALA ridge of the mandibular canines. Intermolar width at WALA ridge (IMWR) was a transverse dimension between the points of the WALA ridge of the mandibular molars**(Figure 2)**. Linear measurements were carried out with digital caliper-Shan (Guilin Measuring and Cutting Tools Co. Ltd, Guangxi, China) modified according to Freire et al[20].

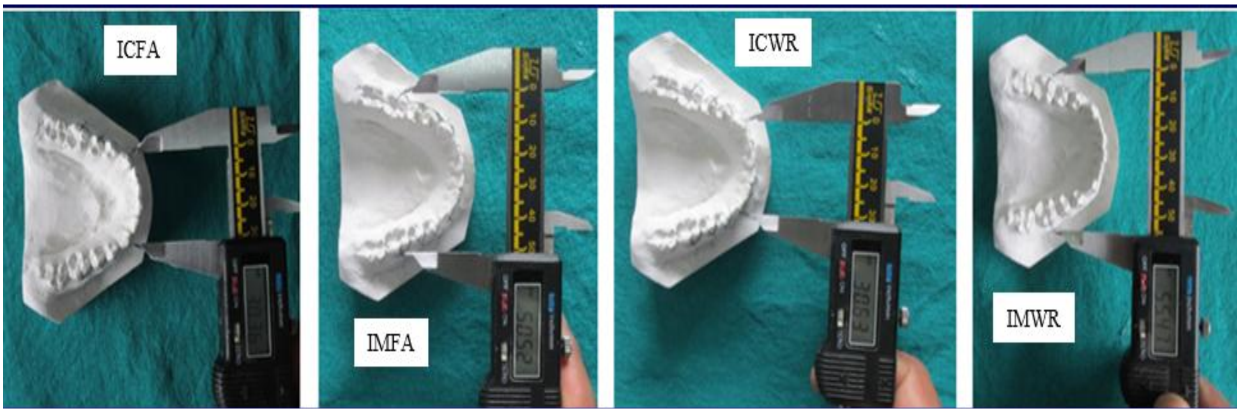

Figure 2: The measurement of ICFA, IMFA, ICWR, IMWR using digital caliper-Shan

Determination of dental and basal arch form:A bracket height gauge was used to mark the bracket placement points on the labial surfaces of the teeth on the cast. The points were marked at the centre of the tooth incisogingivally and mesiodistally along the long axis.In each tooth, from the left first molar to the right first molar, a glass bead was glued to simulate the ideal position of an orthodontic bracket. All beads were initially measured to ensure that the diameter was 1.5 mm and 2 mm (S.D.= 0.1 mm). Each glass bead (1.5 mm) was positioned in the centre of the clinical crown of the incisors, canines, and premolars, and in the middle third of the mesiobuccal cusps in the first molars.

The glass beads of 2 mm were then glued and positioned on the anatomic line of the WALA ridge, adjacent to the FA point. A direct visualization method was used to transfer the bead positions from casts to a polyester film to eliminate magnification error. A clear piece of glass slab of 2 mm thickness was placed over the model to gain a stable platform for 100 micron thick polyester film. The bead positions were transferred on the polyester sheet with a permanent marking pen to simulate 12 clinical bracket points and corresponding WALA ridge points. These points were joined so maximum points could be included in the arch form. The arch forms, thus obtained were classified into the square, ovoid or tapered according to Orthoform^{TM} diagnostic arch form templates (3M Unitek, Calif.).

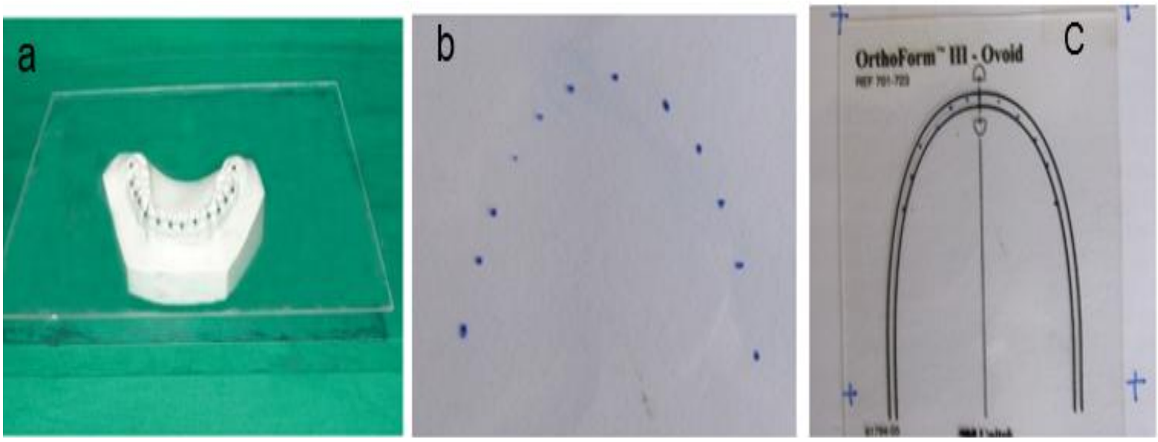

Figure 3: Determination of dental and basal arch form: (a) Glass slab with a polyester sheet laid over the cast, (b) The transferred bead position to a polyester sheet, (c) The OrthoformTM diagnostic arch form templates laid over the polyester sheet

Statistical analysis: The data were coded and entered into Microsoft Excel 2007. The descriptive statistics mean, standard deviation, percentage and frequency were calculated. The Pearson correlation coefficient was used to assess the association between ICFA, ICWR and IMFA, IMWR and Chi square test was used to determine the association between variables at P-value of 0.05 using SPSS version 11.5 (SPSS Inc, Chicago, USA).

RESULTS

One hundred and three mandibular casts were obtained from 103 orthodontic patients. The mean age of the samples was 22.12±3.17 years. Angle's Class I malocclusion (35%) was the commonest type of malocclusion**(Figure 4)**.

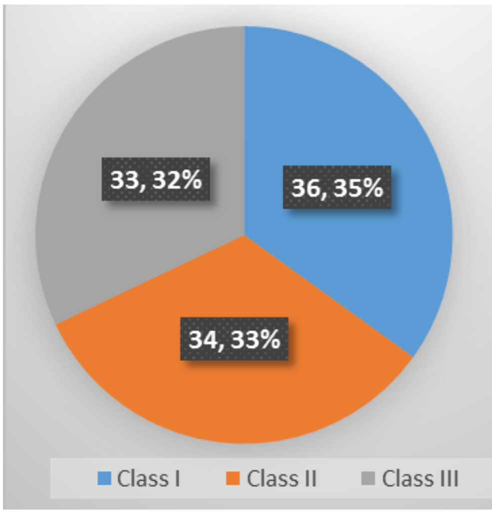

Figure 4: Distribution of malocclusion according to Angle's classes of malocclusion (n=103)

The Kappa value of intraobserver agreement for ICFA, ICWR, IMFA, IMWR, AFFA and AFWR were 0.918, 0.880, 0.840, 0.881, 1 and 1 respectively. There was almost perfect intraobserver agreement for all measurements. Method error was calculated using Dahlberg formula. The method error for the variables was calculated using Dahlberg formula and were between 0.19-0.22 indicating the accuracy of the method.Table 1 and 2 represents the measurements of linear variables ICFA, ICWR, IMFA and IMWR in all samples and in individual malocclusion respectively. Table 3 and 4 represents the distribution of mandibular arch form in all samples and in individual malocclusion respectively.

Table 1: Measurements of linear variables in all samples

Variables	Mean±SD	Pearson Correlation
ICFA	29.1114±2.10	0.787$
ICWR	28.9456±2.29	
IMFA	51.3264±2.94	0.822$
IMWR	56.2030±2.79	

$Correlation is significant.

Table 2: Measurements of linear variables in individual malocclusion

Variables	Mean±SD			P-Value
	Class I (n=36)	Class II (n=34)	Class III (n=33)	
ICFA	29.2839±2.40	28.2841±1.90	29.7755±1.69	0.011*
ICWR	29.3822±2.72	28.0176±1.96	29.4255±1.80	0.014*
IMFA	50.6289±3.15	50.6844±2.16	52.7488±2.97	0.003*
IMWR	56.0575±3.11	55.5962±1.98	56.9870±3.03	0.118

***Statistically significant at P value of 0.05**

Table 3: Distribution of arch form in all samples (n=103)

Measurements	Arch form			P-value
	Square (%)	Ovoid (%)	Tapered (%)	
AFFA	44 (42.7)	42(40.8)	17 (16.5)	0.001*
AFWR	42 (40.8)	48 (46.6)	13 (12.6)	

*Statistically highly significant at P-value of 0.05.

Table 4: Distribution of arch form among different malocclusion

Types of malocclusion	Square (%)		Ovoid (%)		Tapered (%)	
	AFFA	AFWR	AFFA	AFWR	AFFA	AFWR
Class I (n=36)	15 (41.67)	18 (50.0)	17 (47.22)	16 (44.44)	4 (11.11)	2 (5.56)
Class II (n=34)	10 (29.4)	7 (20.6)	12 (35.3)	16 (47.05)	12 (35.3)	11 (32.35)
Class III (n=33)	19 (57.6)	17 (51.5)	13 (39.4)	16 (48.5)	1 (3.0)	0

DISCUSSION

Classifying patients' malocclusion is a very important tool in orthodontic diagnosis and treatment planning. Furthermore, the determination of the shape and size of dental arch form has considerable implications for the success of orthodontic treatment. This concept initiated the concern of orthodontists to conduct several studies to find the best curve fit to describe dental arch forms, through the application of linear (arch width, depth and size), geometric and mathematical models. It is generally accepted that no single arch form is characteristic of a specific malocclusion and customization ofarchwire is always necessary. In this study, the lower arches were used and categorized according to the three types of dental arch form (ovoid, narrow and square) and the pattern of these three shapes of arch form observed showed dissimilar frequency level. Arch form at facial axis point showed the highest frequency for the square form which wasin agreement with the result of Nojima et al[11] for Japanese subjects and Kook et al[10]for Korean subjects. Whereas most prevalent arch form in Caucasians[11] andNorth Americans[10]was Tapered and in Israelis it was ovoid[21]. Conversely to this study, Tajik et al in a similar study of arch forms among different Angle classifications in Pakistan reported that tapered arch forms with 49.2% were more prevalent than ovoid (29.2%) and square (21.2%) type arch forms[22].Among various Angle's classes of malocclusion Class I showed the highest frequency for ovoid (47.22%) followed by square (41.67%) and tapered (11.11%). Class II showed highest frequency for ovoid and tapered (35.3% each) followed by square (29.4%). Whereas class III showed highest frequency for square (57.6%) followed by ovoid (39.4%) and tapered (3%).

This suggested that ovoid arch form was more prevalent in Class I and Class II and square arch form was more prevalent in Class III which was in agreement with the study of Murshid[23]andGafni et al[21]. Of the various parameters for arch form determination, measurement of intercanine and intermolar distance has remained a key. Since, intercanine width and intermolar width serves as anterior and posterior determinant of arch form, most of the studies on arch form are based on the measurement of these variables.In this study, no statistically significant difference in intercanine width at FA point and WALA point was found between groups which was in agreement with the study of Al-Khateeb and Alhaija[24] and differed from the study done by Uysal et al[25].Similarly, no statistically significant difference inintermolar width at FA pointwas found between groups which were in agreement with the findings of Frolich[26]and differed from that of Staley et al[27]. Statistically significant difference was found for IMWR between groups which in agreement with the findings Uysal et al[25] and differed from the findings of Sayin and Turkkahraman[28]. This showed mandibular arch was wider in Class III malocclusion. Braun et alconcluded that the possible explanation for the increase in arch width seen in Class III dental arches may be the adaptability of the tongue to the decrease in available arch depth reflected in an increased lateral tongue dimension[29].It may be due to dental compensation, because mandibular posterior teeth were buccally inclined in Class III patients.In this study the correlation between ICFA and ICWR was high (0.787).Ronay et al[17], Ball et al[8] and Zou et al[30]too found a high correlation of 0.75, 0.843, 0.61 respectively for ICFA and ICWR whereas Kim et al[31] found a moderate correlation of 0.48.The correlation between IMFA and IMWR was found to be high (0.822). Ronay et al[17], Ball et al[8], Zou et al[30]and Kim et al[31] found high correlation between IMFA and IMWR of 0.869, 0.847, 0.91 and 0.85 respectively. The present study indicated a significant association between AFFA and AFWR which was in agreement with the study of Williams[32].

CONCLUSIONS

Our study showed that square followed by ovoid and tapered arch form were present in decreasing order of frequency at FA point where as Ovoid followed by Square and Tapered arch form were seen in decreasing order of frequency at WALA ridge point.A high associationwas found between AFFA and AFWR.Ovoid and square arch form were more prevalent in Angle's Class I and Class III malocclusion whereas ovoid and tapered arch form was more prevalent in Angle's Class II malocclusion. Intercanine and intermolar width were highest in Class III followed by Class I and Class II malocclusion.Arch form derived from facial axis (FA) point can be used reliably to determine individual patient's arch form.Square and ovoid arch form constituted most of the samples at the both levels. Dental arch form derived at FA point can be reliably used to determine individual patient's arch form in clinical setup.Further study having large number of samples should be done with due consideration given to gender and ethnic differences.

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