ORIGINAL RESEARCH

THREE DIMENSIONAL ANALYSIS OF DENTAL ARCH FORMS IN SOUTH INDIAN POPULATION

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ABSTRACT

Aim: The aim of this study was to do a 3-dimensional analysis of the upper and lower dental arch forms and compare the same between male and female South Indian subjects who were not previously treated with fixed orthodontic appliances.

Materials and Methods: The sample consisted of 3D scans of dental casts from 50 untreated patients(25 males and 25 females) in permanent dentition. An assessment of the arch form was performed using angular and linear values on scans using a software(MEDIT).The data was tabulated and statistically analyzed using SPSS software and Student's t test(2- tailed) was used to determine statistical significance of differences in measurements between the two groups.

Results: In male subjects the intercanine, intermolar, interpremolar diameters and arch depth were significantly greater than females and there was a statistically significant difference (p value=<0.05).

Conclusion: Ovoid arch form is commonly seen in both South Indian males and females followed by broader arch forms in males and tapered arch forms in females. South Indian males have wider arches when compared to females.

Keywords: Arch form, Arch width, Dental arch depth, 3D scan (MEDIT), 3 shape ortho analyzer software.

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INTRODUCTION

The assessment of dental arches is of great relevance as they should be maintained throughout treatment to minimize chances of relapse at the end of the orthodontic treatment[1]. A change in intercanine width, during orthodontic tooth movement, might be a reason for dental relapse,hence it is essential to maintain the original arch dimension choosing the suitable arch wire during the entire treatment process[2]. A normal arch shape comprises two different areas: the anterior curvature and intercanine width and posterior curvature and intermolar width. If needed, a preformed archwire can be customized for each patient by adjusting the anterior and posterior curvatures. The arch shape is predicted based on the anatomic dimension of the alveolar ridge, on tooth eruption and perioral muscles[3]. The key clinical factors that affect the dental arch dimensions are arch depth, cross-arch width and dental perimeter. Based on these factors, the dental arch forms have been classified into three types namely, tapered, ovoid and square [4].

Many authors have evaluated the various types of arch forms. Kim et al and Grippaudo et al , evaluated the dental arch forms three dimensionally where the dental landmarks were positioned on occlusal digital photos of plaster dental casts and the correlation of overjet and arch forms in the population with normal occlusion were evaluated to classify the arch forms[5,6]. Numerous other authors have investigated the arch forms in various ethnic groups and also assessed gender dimorphism in the arch forms [7–11].In this study we have compared the arch forms of male and female South Indian subject using 3 dimensional analysis .

MATERIALS AND METHODS

This prospective study consisted of subjects with Class 1 malocclusion, mild crowding and proclination who reported for orthodontic treatment were randomly selected from the Department of Orthodontics Saveetha Dental College, Chennai. Sample size calculation was done using G*Power 3.1(Franz Faul, University of Kiel,Germany)and was selected based on the mean scores obtained from Oliva et al (2018).The total calculated sample size was 50 (25 in each group) based on the mean and standard deviations of the Superior Angle 1 of the maxillary arch (126.4 ± 9.4). The effect size was 0.64 and the power was set at 0.85.The study sample was fifty and equally divided into two groups namely a) group 1-males and b)group 2-females.

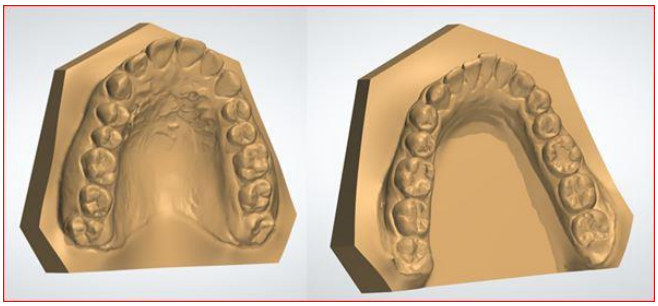
Inclusion criteria

Subjects with class 1 malocclusion, mild crowding, overjet less than 5mm and little's irregularity index less than 4mm in the age group of 18 to 30 years with full complement of teeth from second molar to second molar requiring orthodontic treatment were included in the study.

Exclusion criteria

Patients with rotation of teeth, arch asymmetries, craniofacial malformation, history of dental trauma, oral habits, previous history of orthodontic treatment, or maxillofacial surgery were excluded from the study. In this study scanning of the upper and lower arches of the subjects were performed using the i500 (Medit Corp., Seoul, Korea) intraoral scanner and 3 D scanned models were obtained (Figure 1).

Figure 1 : Figure depicts 3D images of maxillary and mandibular models by using i500 (Medit Corp., Seoul, Korea) intraoral scanner.



A reference plane parallel to the occlusal plane was set on the 3D scan model both in the maxilla and in the mandible. The 3D models were then oriented in an occlusal view. A pentagon (lying on the reference plane) was drawn inside the arches such that a vertex of the pentagon was placed between the two central incisors, two other vertices lied on the cusp of the canines, and the other two were placed at the center of the occlusal face of the first molar.(Figure 2a and 3a)

Figure 2(a,b) : Figure depicts the method and parameters for the arch form analysis of the maxilla.

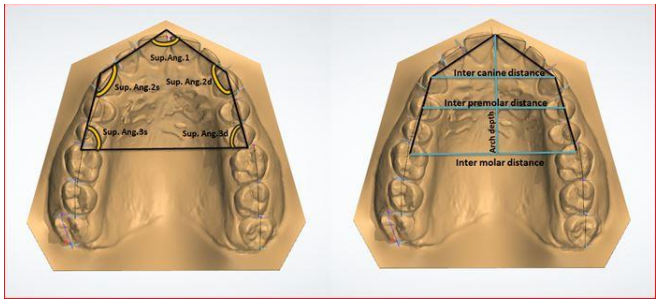
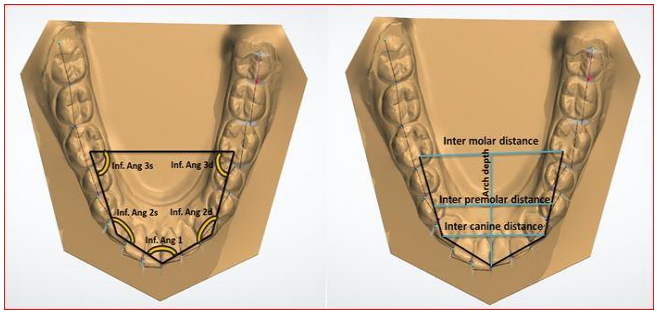


Figure 3(a,b) : Figure depicts the method and parameters for the arch form analysis of the mandible.



The parameters were analyzed in an independent manner on both the upper and lower 3D dental arches(Table 1). The data was subjected to statistical analysis using SPSS version23. Descriptive statistics were performed for all of the parameters assessed. Intra rater relaiability was assessed using Intraclass correlation test (ICC). Shapiro-Wilk'stest($p<0.05$) showed that the parameters assessed were approximately normally distributed for both males and females.Student's t test (2- tailed) was done to find the differences between the two groups.

Table 1: Summary of the parameters assessed in this study.

Parameter	Definition
Intercanine width	The distance between cusps of the two canines
Superior angles	Five in numbers - Superior Angle 1, 2d, 2s, 3d, 3s in the maxilla.
Inferior angles	Five in numbers- inferior angle 1, 2d, 2s, 3d, 3s in the mandible
Interpremolar distance	The distance between the buccal cusps of the two first premolars
Intermolar distance	The distance between the mesial pits of the two first molars
Intercanine-intermolar distance ratio	Ratio between intercanine distance to the intermolar distance
Arch depth	The distance from the anterior vertex of the pentagon to the line connecting the occlusal pits of the two first molars

RESULTS

Mean and standard deviation of the parameters for the two groups are summarized in the Tables2&3. All measurements are mentioned with angular values in degrees (°) and linear values in millimeters (mm). Student t test for comparison of the maxillary arch parameters is mentioned in table 2. The mean differences between the angular measurements were not statistically significant, except for the Sup. Ang. 1 which was greater in males (P =0.013). All the linear measurements (intercanine distance, inter premolar distance, inter molar distance, arch depth) in the study showed statistically significant differences between the two groups ($P<0.05$), and the values were greater in male subjects.

Table 2:Table depicts the mean and standard deviation of the parameters and is divided into two groups: males and females.

	MALES		**FEMALES**		
	Mean	**SD**	**Mean**	**SD**	**Significance**
Sup.ang.1	116.5±3.9	3.92	115.8 ±2.8	2.8	0.013
Sup.ang.2d	133.57	4.56	131.0 8	4.0 2	0.840
Sup.ang.2s	133.78	5.27	131.0 8	4.0 2	0.105
Sup.ang.3s	74.21	4.03	75.1	3.1 4	0.339

Sup.ang.3d	74.62	3.15	75.58	4.33	0.238
Interpremolar distance	38.7	2.01	36.39	2.18	0.015
Intercanine distance	35.13	2.53	34.65	3.06	0.013
Intermolar distance	47.41	2.76	44.28	2.51	0.034
Arch depth	34.76	2.05	32.84	3.21	0.012
Intercanine-intermolar ratio	0.84	0.05	0.75	0.07	0.324

In the mandible, none of the angular measurements were significant. On the other hand, all the linear measurements were significant (P<0.05). As in the maxilla, these measurements were greater in males than in females. It was found that males had significantly greater maxillary and mandibular dental arch widths and depth than females (P =0.012 and 0.005 respectively). However, the dental arch forms were similar among both males and females.

Table 3: Table depicts the mean and standard deviation of the parameters and is divided into two groups: males and females.

	MALES		**FEMALES**		
	Mean	**SD**	**Mean**	**SD**	**Significance**
Inf.ang.1	128.26	3.02	127.76	2.1	0.840
Inf.ang.2d	132.01	11.99	129	7.07	0.200
Inf.ang.2s	131.23	10.37	131.84	6.9	0.810
Inf.ang.3s	100.73	134.99	129	7.07	0.340
Inf.ang.3d	70.57	3.28	73.51	3.51	0.453
Interpremolar distance	32.6	2.53	32.77	1.77	0.048
Intercanine distance	25.31	1.73	26.12	1.72	0.016
Intermolar distance	42.59	2.39	41.17	2.48	0.043
Arch depth	29.6	2.15	27.73	2.09	0.005
Intercanine-intermolar ratio	0.68	0.07	0.57	0.06	0.243

DISCUSSION

Arch forms were first classified as tapered, square, and ovoid by Chuck in 1932 and Felton et al [12,13]. Assessing the arch form allows customization of the arch wires that would benefit the treatment of a patient than a single arch form approach especially during the initial leveling and aligning phase as individuals vary widely in their arch forms. This study was done to examine the differences in maxillary and mandibular arch forms among South Indian males and

females, and also the differences in their transversal dimensions were measured using 3D models. From this study, we noted significant differences in the linear measurements and males had broader arch forms than females.

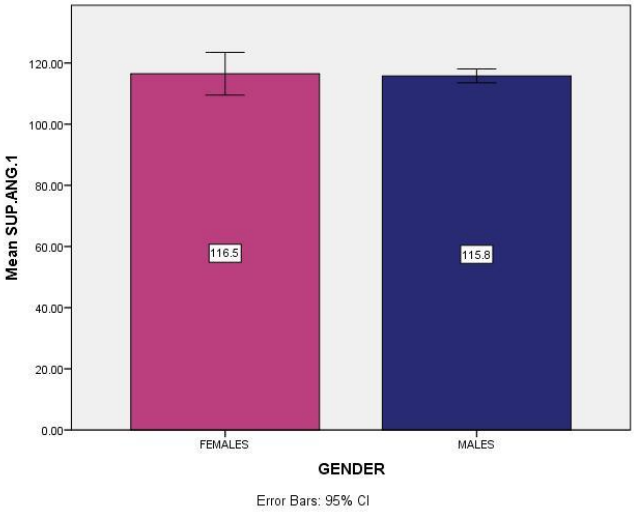
Nojima et al used tapered, square, and ovoid templates to assess the arch forms of Class I, Class II and Class III cases in Japanese and Caucasian populations. They concluded that in Caucasian population tapered arch forms(44%) were most common followed by ovoid arch forms(38%) and square arch forms(18%) whereas Japanese people had square arch forms(46%) followed by ovoid arch forms(42%) and tapered arch forms(12%)[14]. Oliva et al showed that there were also gender differences in the arch forms in their study on the Italian population[15]. In a study by Sonal et al, the arch forms of Indian male students were 20% narrow, 10% wide and 10% normal arch form. Whereas those of the Indian female students were 30% narrow, 10% wide and 20% normal arch forms.[16] This shows that archforms vary with different races and that they also vary within the individuals as well as the gender of the same race. There have been studies in which gender differences in arch forms were studied and the arch form of the females were found to be more tapered than that of males[17–21].

In this study, the gender differences between the maxillary and mandibular arch forms were studied. The linear measurements had statistically significant gender differences whereas in the angular measurements, the gender differences were statistically insignificant except for the Sup.Ang 1(table 2).This value (Sup.Ang 1) was greater in males than in females The males demonstrated larger transverse and longitudinal dimensions for both maxillary and mandibular arches than females. The present study infers that the arch depth was significantly greater in males than females($P<0.05$), this is in line with the study by Christie[22] which reported that the arch depth is greater in males than in females. From this study, it can be concluded that there is no significant difference in angular measurements among male and female arch dimensions except for the maxillary anterior region, which was lesser in females but all the linear measurements were significantly more in males.

Slaj et al, concluded that among genders, there are significant differences in the linear measurements of the dental arches, but not in ratio parameters (inter canine-intermolar ratio). All the measurements were generally more pronounced in males than in females[23]. Whereas, Camporesi et al. evaluated the mean configuration of the dental arches in the population of Southern European subjects with ideal occlusion using a three-dimensional analysis and did not find any differences in the maxillary and mandibular arch forms in males and females[24]. The results of the present study are in agreement with that of Forster and coworkers[25] and Oliva et al[15]. Oliva et al study compared the arch dimensions between the males and females in the Italian population. In comparison to the Italian population, the Sup. Ang. 1 was decreased in the South Indian population in the present study and the difference was found to be less in males than in females (table 2). The intercanine width was more in the South Indian male population compared to the Italian population, indicating that arch is wider in the South Indian subjects.

In the present study, even if there was a minor dental crowding, the points were marked on the references that have been already set for the study. For future studies, it would be appreciable if the relationship between the role of dental crowding and arch form can be identified.

Figure4: The bar graph represents the comparison between the mean Superior angle 1 and the gender.. The mean Superior angle 1 value for male and female study subjects were 115.8±3.9 and 116.5±2.8 respectively



CONCLUSION

The following conclusions can be drawn from the present study:

1. Ovoid arch form is commonly seen in both South Indian males and females followed by broader arch forms in males and tapered arch forms in females. South Indian males have wider arches when compared to females.

2. In females the arches were narrower in the anterior region when compared to males.

3. Due to the anatomical differences in arch forms between genders it is recommended to consider each patient's pre-

treatment dental arch form, width and depth before starting orthodontic treatment.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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