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ASSESSMENT OF MEAN DISTANCE BETWEEN CENTRAL INCISOR AND INCISIVE PAPILLA WITH RESPECT TO STANDARDIZED ARCH FORM IN DENTATE SUBJECTS

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ABSTRACT:

BACKGROUND & OBJECTIVE: Edentulous patients require accurate positioning of artificial maxillary anterior teeth in complete dentures to recover the esthetic and phonetic characteristics. This positioning is guided by measuring distance between central incisor (CI) and incisive papilla (IP) in dentate subjects which varies according to the ovoid, square and tapered maxillary arch forms. Objectives of the study is to determine the frequency of three different arch forms in dentate patients; and to assess the mean distance between central incisor and incisive papilla in each of the three maxillary arch forms.

METHODOLOGY: 130 cases were selected by non-probability consecutive sampling, which included both genders and age range of 20-40 years. Impressions of maxillary arches were recorded and their casts photocopied. Arch form template was used to standardize the assessment of arch forms by best-fit method on the photocopies. The distance between mesio-incisal edge of CI and posterior border of IP was measured with digital verniercalipers (SparkFun,Colorado).

RESULTS: Out of 130 subjects, 54 males and 76 females were present. The ovoid arch form was the most frequent form recorded at 67% (n=87) while the tapered arch was the least at 14% (n=18). The overall mean distance between central incisor (CI) and incisive papilla (IP) was 11.34mm (7.58mm - 16.45mm). The mean distance was the highest for ovoid arch form (11.58mm) and lowest for square (10.49) with a statistically significant difference (p=0.016) between the two arch forms.

CONCLUSION: The ovoid arch was the most frequent arch form found in dentate subjects. The mean distance recorded was highest for ovoid arch followed by tapering arch and least for square arches.

KEYWORDS: Incisor, Palate, Dental arch, Maxilla, Odontometry

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INTRODUCTION:

Smile is the esthetic guide of the face. A pleasing smile has several psychological effects including improvement in a person's self-image and confidence [1-3]. The loss of maxillary anterior teeth in partial or complete edentulism leads to speech problems and loss of upper lip support, thereby deteriorating phonetics and esthetics of patients, respectively. To correct this state, the artificial maxillary anterior teeth in the complete or partial dentures are placed in the position of their natural predecessors [2,4]. This positioning is governed by pre-extraction records and biometric guides of the patient. In the absence of pre-extraction records, there is a need to select an anatomical landmark that acts as a reference for the appropriate positioning of the artificial teeth in complete dentures [2,5].

The incisive papilla is a stable, immobile landmark which does not shift in later life [6]. It is a small oval mucosal prominence situated along the midline of the palate, posterior to the palatal surface of the maxillary central incisors in dentate patients. In the edentulous maxilla, it is a round prominence behind the crest of the residual ridge [7]. The anterior border and center of papilla are likely to change after extraction of central incisors, while the posterior border remains relatively stable in position and form [6,8]. Hence, the horizontal distance between the posterior border of incisive papilla and maxillary central incisors in fully dentate subjects can be measured and used as reference for positioning the prosthetic teeth in edentulous patients [4,7,8].

There is variation in different studies regarding the criteria for the measurement of distance between central incisor and incisive papilla [4-10]. Some researchers have advocated the midpoint of the incisive papilla while others have used the posterior border as the posterior reference point [4-10]. The anterior reference point is also not in agreement. The mesio-incisal edge, the disto-incisal edge and the most prominent labial convexity of the central incisors have been used as references [4-8,10].

Arch form is the configuration of the dental arch and is created by the relationship between the teeth and the alveolar bone [2]. The permanent teeth eruption follows the arch form which is unique in size and shape to each individual [11,12]. It is morphologically classified as ovoid, tapered or squarish. Hence, prosthetic teeth have to be arranged according to the arch form.Tajik et al found the frequency of tapered, ovoid and square arch forms as 49.2%, 29.2% and 21.2% respectively [13].

The incisive papilla to central incisor distance varies with respect to the three morphological maxillary arch forms [4,8]. Avhad et al measured the mean distance as 9.6mm ±1.3 for squarish, 9.9 mm ±1.5 for ovoid and 10.9mm ±1.2 for tapered arch, respectively [4]. Conversely, a local study conducted by Zia et al measured the mean distance as 10.5mm, 11.2mm and 13.0mm for squarish, ovoid and tapered arch, respectively [8]. In these studies the arch forms were identified on subjective assessment without the use of any template or formulae.

Selection of arch forms through templates is important for standardization and to remove subjective bias. Saleem et al used Noroozi's mathematical formula and orthoform template to assess the frequency of arch forms. According to orthoform template, frequency distribution of ovoid, square and tapered arch forms was found to be 53.2%, 9.2% and 37.6% respectively [14].

Appropriate positioning of anterior artificial teeth in edentulous patients for esthetics necessitates the measurement of the central incisor to incisive papilla distance in dentate subjects. Therefore, this study was conducted to measure the frequency of the three different arch forms in our local fully dentate population. In addition, the mean distance between incisive papilla and central incisor were measured of the three maxillary arch forms found in the dentate subjects.

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METHODOLOGY:

This cross-sectional descriptive study was conducted in the Dental Out-Patient Department of Fatima Memorial Hospital (FMH), Lahore, after taking approval from the ethical committee (IRB) of FMH College. The study

duration was from September 2017 to 4th March 2018. Fully dentate maxillary arch patients, aged 20 to 40, were included in the study. Maxillary teeth with surface loss, malalignment, diastemata, fixed prosthesis, mobility and/or history of orthodontic treatment were excluded from the study. An informed consent was taken from participants ensuring confidentiality of their data and this data was recorded in a specially designed proforma. The study comprised of 130 cases. This sample size was calculated with 95% confidence interval, 7% margin of error and with expected percentage of square arch form i.e. 21.2% [13].

Impressions for the maxillary arches were recorded with irreversible hydrocolloid impression material (Alginate, CA37, Cavex, Netherlands, ISO 21563). After disinfecting with chloride compound disinfectant (Practice Safe, Kemdent Works, England), impressions were poured with Type III gypsum dental stone (CKH-52, Kuang Pang, ISO9001:2000) to obtain the cast. Photocopies of the occlusal surfaces of the casts were obtained with a photocopier on a white paper. Arch forms were assessed using arch form template (Orthoform, 3M Unitek) to remove bias. The template was overlaid on the photocopied images of the maxillary arches and the arch form selected according to the best fit. The subjects were divided into three groups according to the maxillary arch form, i.e. squarish, ovoid or tapered.On each stone cast, the mesio-incisal edge of CI and posterior border of IP was marked by a lead pencil as the anterior and posterior reference points, respectively. The distance between these landmarks was recorded with digital vernier calipers with an accuracy of 0.01mm (SparkFun,Colorado). After three measurements of each cast, the mean distance was recorded.

Data collected was entered in SPSS version 20 and analyzed. The qualitative data was presented in the form of frequency and percentages i.e. gender and arch forms. The quantitative data was presented in the form of mean and standard deviation i.e. age and distance between CI and IP. Data was stratified for gender to address the effect of modifiers. One-way ANOVA was applied to compare mean values of distance between CI and IP with respect to arch form and also post-stratification, where result with p-value of 0.05 or less was considered significant.

RESULTS:

One hundred and thirty patients models were made for this study. Attrition rate of study participants was Zero. Out of 130 subjects, 54 were males whereas 76 were females. 87 patients had ovoid maxillary arch, 25 had square maxillary arch and 18 had tapered maxillary arch.

The mean age of the patients was 25.35±4.84. The mean distance between the incisor and the IP was recorded as 11.34±1.76mm. Table I shows frequency distribution for gender according to arch forms.

Table-I: Frequency distribution of gender according to arch form.

Gender	Arch form	Frequency	Percentage %
Male	Tapered arch	9	16.7
	Square arch	13	24.1
	Ovoid arch	32	59.2
	Total	**54**	**100**
Female	Tapered arch	9	11.8
	Square arch	12	15.8
	Ovoid arch	55	72.4
	Total	**76**	**100**

Table-II– The data stratification for gender.

Gender	N	Mean (mm)	Standard Deviation (mm)	p-value
Male	54	11.34	1.81	0.981
Female	76	11.34	1.74	
Total	130	11.34	1.76	

Data was stratified to check the significance between the two groups of genders. There was no statistically significant difference between the groups (p= 0.981).Table III demonstrates the mean distance according to arch forms.

Table-III: Mean Distance according to Arch Forms.

Arch Forms	N	Mean (mm)	Standard Deviation (mm)	p-value
Tapered	18	11.35	1.84	0.022
Square	25	10.49	1.79	
Ovoid	87	11.58	1.68	
Total	130	11.34	1.76	

Data was stratified to check the significance between the three groups of arch forms. There was a statistically significant difference between the groups (p=0.022).Table IV shows post-stratification for gender with arch form and CI-IP distance.

Table-IV: The post-stratification for gender with arch form and CI-IP distance.

Arch Form	Gender	Mean (mm)	Std. Deviation (mm)	n
Tapered	Male	11.66	1.17	9
	Female	11.04	2.36	9
	Total	11.35	1.84	18
Square	Male	10.60	2.08	13
	Female	10.37	1.48	12
	Total	10.49	1.79	25
Ovoid	Male	11.56	1.80	32
	Female	11.60	1.63	55
	Total	11.58	1.68	87

One-way ANOVA was applied to compare mean values of distance (between CI and IP) in the 3 different arch forms. There was a statistically significant difference between the groups ovoid and square arches (p= 0.016). Table-V demonstrates the comparison.

Table-V: One-way ANOVA to compare mean values of distance in the three arch forms.

Arch form	Arch form	Mean Difference	Standard Error	p-value
Tapered	Square	.862	.533	.242
	Ovoid	-.235	.446	.859
Square	Tapered	-.862	.533	.242
	Ovoid	-1.097	.391	.016
Ovoid	Tapered	.235	.446	.859
	Square	1.097	.391	.016

DISCUSSION:

The majority of edentulous patients requiring complete dentures to restore their teeth do not have pre-extraction records to guide the placement of the prosthetic teeth. In the absence of pre-extraction records, biometric guides are useful in determining positions of denture teeth [15]. The IP is a stable landmark and the mean distance between CI and IP in dentate subjects gives a reliable guide to position the maxillary anterior teeth in complete dentures [7]. This mean distance varies with the three maxillary arch forms; tapered, square and ovoid; hence, anterior teeth positioning should follow these arch forms [13,14].

A total of 130 subjects were selected for this study out of which 54 were males and 76 females, at 41.5% and 58.5% respectively. This is contrary to other studies that had either selected equal number of subjects from both genders, or those who created equal number of arch form groups [4,8,14]. Zia et al conducted their study on 150 subjects, with 75 males and females each [8]. Saleem et al used 250 subjects, equally divided into 125 males and females each [14].In the current study, non-probability consecutive sampling was used to select the subjects, hence the unequal distribution of gender and arch forms.

To standardize the assessment of the maxillary arch forms, orthoform template was used in this study. The use of template to assess arch form is in accordance with many authors who have recorded the frequency of these arches [8,13,14,16-18]. The template allowed accurate assessment of arch forms according to the best-fit method and helped to remove subjective bias.

In the current study, ovoid arch form was the most frequent arch form recorded at 67% followed by the square arch at 19%, while the tapered arch was the least recorded form at 14%. This higher frequency of ovoid arch is concurrent with that recorded in one of the earliest studies conducted by Ehrlich and Gazit at 64% [17]. Their result for least frequent tapered arch (10%) is also in agreement. However, the results of this study are converse to those of Nojima et al (Japanese population), Olmez et al (Turkish) and Tajik et al (Pakistan), all of whom recorded a lower frequency of ovoid arch form at 38%, 27.3% and 29.2% respectively [13,16,18]. Tajik and Olmez both recorded the highest frequency for tapered arch form at 62.5% and 49.2% respectively, a stark contrast to the result of the current study [13,16]. Majority of these studies were not local which also helps to explain the difference in the frequency of arch forms recorded amongst various racial populations.

In the present study, the frequency of arch forms according to gender also showed ovoid arch as the most frequent among both males and females at 59.2% and 72.4% respectively. The tapered arch was again least frequent among both genders; males at 16.7% and females at 11.8%. The higher frequency of ovoid arch form in females compared to males can be attributed to the higher frequency of overall female subjects in the study. These results are in concordance with those of Zia et al whose frequency for ovoid arch was highest among both males (57.3%) and females (68%), while the tapered arch was 10.3% for

males and 13.3% for females [8]. This validates the highest frequency of ovoid and least of tapered arch form since Zia et al's study included equal number of male and female subjects, while the distribution of genders in the present study was unequal.

The current study included selection of subjects in the age range of 20-40 years. The mean age of the subjects was recorded as 25.35 years. This age range is in similarity to many studies.and provides a good number of dentate individuals since tooth loss accelerates after 40 years of age [4,8,14,19].

This study used the mesio-incisal edge of the CI and the posterior border of the IP as the anterior and posterior reference points, respectively. The overall mean distance recorded between the two references was 11.34mm ±1.76mm. No statistically significant difference was observed between gender groups as both male and female subjects showed the same reading of 11.34mm. This reading was in converse (and in a higher range) to the earliest studies of 1950-70 which recorded the distance of 8-10 mm [2,20]. However, these readings were on a lower range than those of the next generation of authors (1970-90) who recorded the distance of 12-13mm [17,21]. With the turn of the millennium, the most recent authors have recorded the mean distance as 11.96mm and 11.92mm [7].This study is in consensus with the recent intermediate range most probably because the selected subjects fall under the same generation. Moreover, the current study recorded an unprecedented maximum distance of 16.45mm which explains the large variations present among local as well as global populations [22].

The IP to CI distance varies with respect to the three maxillary arch forms. The results of this study support the findings of a local study by Zia et al who recorded the mean distances for ovoid and square arch forms as 11.2mm and 10.5mm respectively. However, the highest mean distance recorded was for the tapered arch form (13.0mm)[8]. Moreover, the readings of the present study are in converse to an international study by Avhad et al who found the distances as 9.99mm, 9.67mm and 10.91mm for the ovoid, square and tapered arches respectively [4].

Among the genders, the highest mean distance was recorded for the tapered arch form in the male group as 11.66mm while the lowest distance was recorded for the square arch form in the female group as 10.37mm. This was synchronous with Zia et al who also recorded the highest mean distance for the male tapered arch (13.0mm) and the lowest distance for the female square arch (10.0mm) [8].

The readings of this study were more in coherence with those of local Zia et al than those of Avhad et alsince the population characteristics were more or less the same [4,8].

Overall, the ovoid arch form showed the highest frequency, suggesting its greater need in Prosthodontics as well as the highest mean distance indicating that artificial tooth for this arch form should be positioned farther from the IP than the tooth position for tapered and square arch forms.

CONCLUSION:

The aim of a Prosthodontist is to provide esthetically pleasing complete dentures to edentulous patients, which emphasizes the need to accurately position the maxillary anterior teeth. The distance of CI to IP in dentate subjects varies with the three maxillary arch forms and provides a guide for tooth positioning in edentulous patients.In this study, ovoid arch was the most frequently occurring arch form in dentate subjects. In addition, the mean distance recorded was highest for ovoid arch followed by tapering arch and least for square arches.

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Author's Contribution:

Ussamah Waheed Jatala: Conception, Design the study & reference collection.

Anam Fayyaz Bashir: Data collection & Analysis.

Nazia Yazdanie: Drafting & Editing.

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