Original Article

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Three-dimensional of lingual arch form and creation of templates in Iraqi normal occlusion

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Abstract

OBJECTIVES: To evaluate the lingual dental arch form types in class I canine and molar relationship based on scanning dental cast models using three-dimensional laser scan and to give a new lingual arch form pattern created on this classification to be used for clinical submission by studying three-dimensional virtual models of the normal occlusion samples.

MATERIALS AND METHODS: Maxillary and mandibular casts of 120 young adults (18-24 ± 1.84 years) have normal occlusion that was scanned using a 3Shape E1 laser scanner, and then, the data were analyzed using SPSS software; then, we used K-means cluster to classify the arch form into clusters depending on the measurement of 10 landmarks designated on the lingual surface of the teeth.

RESULTS: Many dental arch patterns have been established for both the mandible and the maxilla.

CONCLUSION: The minimum sizes were found in the females, and the biggest sizes were found in the male subjects, and three sets were well defined for each sex; three categories for each mandible and maxilla are as follows: narrow, mid, and broad. The lingual arch form can be classified into three groups based on posterior and anterior dimensions, so a template of the three arch forms has been exemplified.

Keywords:

Cluster analysis, lingual arch dimensions, lingual arch form, three-dimensional virtual models

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Introduction

The evolution of the arch form concept

The evolution of an arch form shape, predominance, and components, as well as deciding and selecting them, are shielded in this research review; in 1885, Bonwill advocated that a mandibular arch was to stay like a tripod-shaped and an equilateral triangle that was molded by connecting the midline and the two condyles,[1] whereas in 1905 Hawley alongside with Bonwill projected a geometric scheme for calculating and prearranging the dental arches, in which the mandibular anterior teeth were set on a curvature of a sphere and the molars and premolars allied with the third and second molars turned in the direction of the center. It was also adjusted by Boone in 1963, whereas in 1907 E. H. Angle developed the term "line of occlusion." Also, it has been proposed that the line formed between the premolars and molars is shaped like a parabola.,[2] and in 1934, Chuck recognized the variance in arch form, that is, tapered, square, and ovoid.,[3] and then, in 1949 according to the statement of Macconaill and Scher, the mandibular arch form is generated by the slack of the chain with both ends apart. The catenary curve was attributed to it,[4] and then, in 1972 Brader, by narrowing the arch form beyond the first permanent teeth, innovated the concept of a catenary curve called a trifocal ellipse,[5] whereas in 1998 Braun *et al*. reported that a mathematical formula called the beta function might be used to represent the human arch.[6,7]

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The dental arch form remains an essential element in orthodontic judgment and also plays important role in treatment planning because of its skill to impact not only the accessible space and smile and dental esthetics but also long-term occlusal stability (Triviño *et al.*,[8] 2008) (Syakirah *et al.*,[9] 2021). Andrews, the father of the labial straight wire technique, cited the arch form mirrored as the seventh of his keys to achieve class I occlusion.[10]

Only a limited population-specific reading regarding the grouping of lingual arch forms was available, and Lombardo *et al*. (2010) designated three arch forms, explicitly small, medium, and large forms for the European inhabitants;[11] Park *et al*. (2015) used three-dimensional computer-generated reproductions for making digital coordination points and designated four gatherings in the Korean inhabitants, explicitly narrow, wide, ovoid, and tapering types; and Kairalla *et al*. (2014) used linear dimension as a substitute for polynomial equations to define arch forms in Caucasian Brazilian residents and reach the conclusion that the lingual arch form has a parabolic shape and slightly flattens in the anterior ratio.[12,13]

Dental arch length, morphology of the anterior teeth, bilateral intermolar distance, and bilateral intercanine distance were taken into account as factors manipulating the characterization of dental arch form, and also, the dental arch length is considered an important pointer for dental arch size determination and is largely influenced by distance from the interincisor point to the inter 2nd molar line of the maxilla and mandible; however, the dental arch width has an influence on the determination of the form of the dental arch.[14]

The purpose of this study was to evaluate the 3D lingual arch form of angle class I of (X) population and simulate the arch form of other ethnic groups.

Materials and Methods

Study design

A total of 120 pairs of the cast were obtained, and then, it was scanned by a 3Shape E1 scanner; afterward, the required measurements were taken and arranged in the Microsoft Excel program, and the data were processed by the SPSS program; at the beginning, we used the descriptive statistics as mean and standard deviation, and then, we used the K-means analysis to obtain clusters from each arch of males and females; in the end, we inserted the data in the AutoCAD program to draw the arch forms of each arch.

Sample size calculation method

The sample of this retrospective study consist of 120 patients.

The sample size was calculated based on a single mean formula as follows:

[n = (z r/D) 2],

where n = sample subjects

z = (constant) = 1.96 for 95% confidence

r = (standard deviation) = 1.1

D (precision) = 0.2 unit.

The resulting number was adjusted, and the final sample size = 120.

The sample of the cross-sectional retrospective study was carefully selected depending on records of retrospective data at (X) Specialized Center for Dental Services; it consists of 120 pairs of casts of young adults (18–24 years old) (SD ± 1.84) who have normal occlusion (64 females and 56 males), as shown in Table 1, which are selected from casts of 357 pairs of casts, and the inclusion criteria of the sample were as follows: angle's class 1 molar and canine relations, overbite <1 mm and overjet <4 mm, insignificant tooth size—arch length inconsistency (<3 mm crowding of teeth, <1 mm spacing between teeth), flat or minor curve of Spee (<2 mm), nonexistence of crossbite or aberration dental midline, permanent dentition with normal tooth shape and size, and not undergoing previous orthodontic treatment.

Measuring the curve of Spee

The depth of the curve of Spee was measured as the perpendicular distance between the deepest cusp tip and a flat plane that was laid on the top of the mandibular dental cast, touching the incisal edges of the central incisors and the distal cusp tips of the most posterior teeth in the lower arch. The measurement was made on the right and left sides of the dental arch, and the mean value of these two measurements was used as the depth of the curve of Spee.[15]

3Shape E1 scanner

Three-dimensional virtual maxillary models were acquired using a 3D laser scanning system (3Shape E1 scanner) (3D viewer in 3Shape 2014.1" (build: 1.3.2.0"—16/12/2013). The 3D laser scanner fabricated the 3D computer-generated models from maxillary and mandibular dental casts that have an accuracy of 10 um (ISO 12836) and a resolution of 1,024 × 768 pixels. The accuracy and reliability of the scanning result in an accuracy of 10 um (ISO 12836), as shown in Table 2 and Figure 1.

Mandibular and maxillary casts were scanned using a 3D laser scanner from a 3Shape E1 scanner set at 10 µm

Table 1: Descriptive statistics of age

	Number	Mean age (year) (±SD)	Min (year)	Max (year)
Male	56	21.7±1.93	18	24
Female	64	20.51±1.78	18	24

Table 2: Properties of 3Shape E1 scanner

Properties	Values
Cameras	2X5 MP
Full arch scan time	32 seconds
Impression full arch scan time	104 seconds
Accuracy (ISO 12836)	10 um
Scanning strategy	Standard

resolution. The central point of the lingual surface of the tooth was centered using 3D viewer software from 3Shape.

In this study, seven reference points were taken as landmarks as nominated by Lombardo *et al.* (2010).[11] For the maxillary anterior teeth, the reference points were manifested at the intersection of the gingival and the middle third teeth, whereas the reference point for the mandibular anterior teeth was located in the middle third of the clinical crown through the central lingual axis; however, in the maxillary posterior teeth the orientation points were striking at the center of the clinical crown, while in the mandibular arch, the orientation points will be patent at the center of the clinical crown (regarding the vertical position) alongside the central lingual axis and at the peak projecting point on the lingual surface of each tooth (regarding the horizontal position) on the premolars and the molars. These orientation points are responsible for a direct clinical illustration of the lingual side of the arch (Lombardo *et al.* (2010)),[11] as shown in Figures 2 and 3.

Three sagittal and three crosswise dimensions were used to establish the size of the dental arches: The intercanine width, the average intermolar width (L) between the first molars (L.u), and the width between the second molars were used to determine the arch width. The arch length was determined according to the "arrow" for the anterior curve of the arch called canine depth, the mean arch length between the two first molars, and the total arch length measured between the mark point between the central incisors and line joining the distolingual cusp of the two second molars, and these six factors characterize both the dimension and form of the dental arch, as long as only the form is concerned, and three ratios are important: 1. canine depth/canine width, 2. inter 1st molar depth/inter 1st molar width, and 3. inter 2nd molar depth/inter 2nd molar distance.

The classification was performed according to these three ratios, and K-means clustering was carried out to classify the arch form into clusters; the Euclidian distance was calculated from these ratios, and the whole was used as a criterion for classification, and the smaller the Euclidian distance between the two dental arches mean, the more similarity there is in their forms.

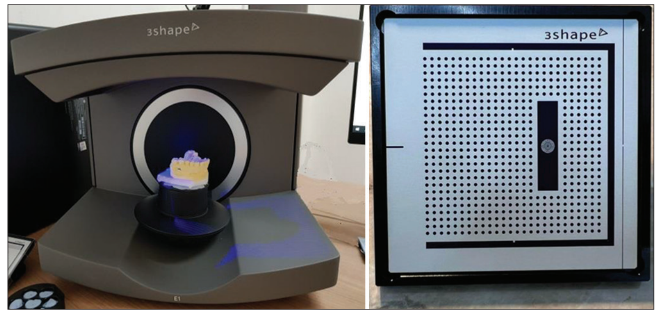

Figure 1: Picture of 3Shape E1 scanner and calibration pad

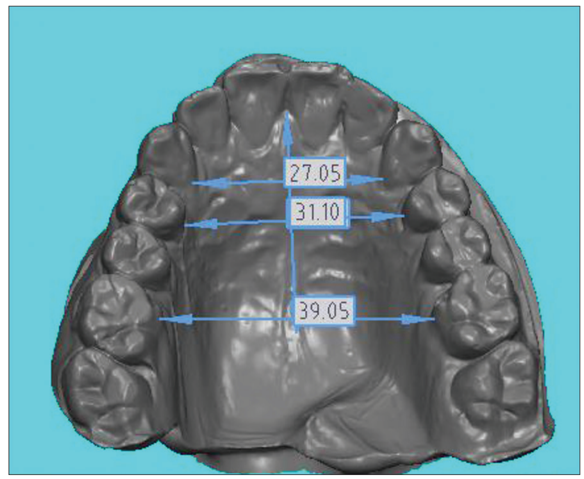

Figure 2: Multiple readings of each sample by 3Shape 3D viewer

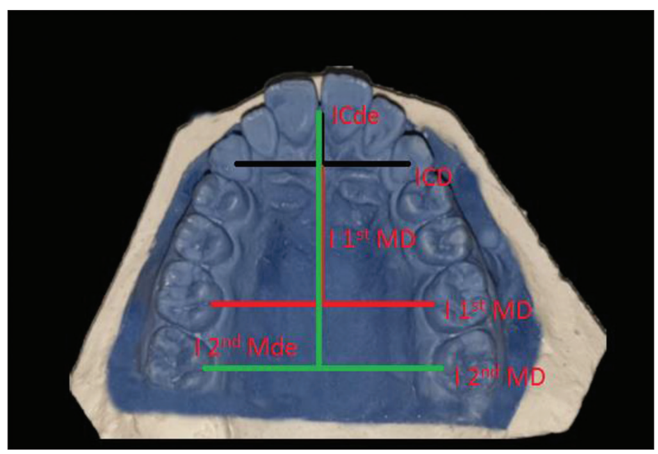

Figure 3: Stone cast showing different measurements ICD: intercanine distance, ICde: intercanine depth. I 1st MD: inter first molar distance, I 1st Mde: inter first molar depth. I 2nd MD: inter second molar distance, I 2nd Mde: inter second molar depth

The dental arch dimension was measured using a 3Shape E1 laser scanner with an accuracy of 10 um. At each measurement session, calibration was carried out for the appliance (in accordance with surrounding light, temperature, and humidity) to increase accuracy and reduce intra-examiner and inter-examiner inaccuracies, and each pair of casts was stored in nylon bags and enveloped by hard napkins to minimize the effect of air humidity and increase the accuracy of the reading of the appliance. Each cast is fixed alone in the scanner, and Blue Tags is used to stabilize the cast on the holding surface of the appliance in order to ensure the full stability of the cast over the holding surface of the scanner (because the holding surface of the appliance will rotate many times during the scanning process).

Scanning data are exported to the 3Shape Scanlt Dental 2017 program (1.17.5.1); for each arch and sample, we choose the type of scanning, and then, the type of scanning that we want is entered; then, the order is given to scan. Sometimes, after initial scanning we can select the area that needs more fine detail to rescan the selected area, as shown in Figure 4.

The scan data were organized in a special form (DCM 3D Model file); then, we manipulate in 3Shape Scanlt Dental 2017 to produce a more favorable form (STL), and measurement was carried out from a 3D viewer in 3Shape 2014.1" (build: 1.3.2.0"—16/12/2013) using the distance tool that measures the distance between two points with an accuracy of 10 um, and then, every measurement is exported to the specific row in Microsoft Excel software (14.0.4760.1000) and classified in the table

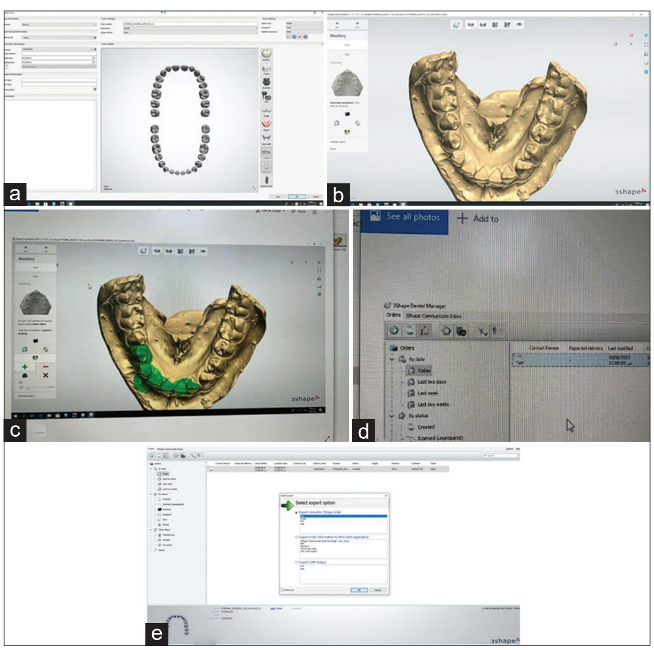

Figure 4: (a) Main page of program 3Shape Scanlt Dental 2017, (b) selection of scanning cast and modified scanning orders, (c) selection of area for more selective scanning to ensure maximum accuracy, (d) 3Shape dental manager program order page that allows opening previous scanning and also exporting it to the selected format, (e) 3Shape dental manager program selection of export format

containing all samples and records, and also, a column on specific measurements (e.g., intercanine width, intercanine depth, and intermolar width) is easily made.

Inter-examiner and intra-examiner calibration

Statistics analysis for the purpose of the comparison between the first and second measurements was carried out by the same examiner (intra-examiner calibration), and the results showed that no significant difference was found between the mean value of the whole reading of the second and first readings; also, we found no significant difference between the first and second examiners (the inter-examiner calibration); this was performed using the "t-test" at a significance level of $P > 0.05$ and assessment of the dependability of measurement with a paired *t*-test.

Results

The descriptive statistics (standard error, standard deviation, and maximum and minimum) of each group is described separately according to arches and gender; the mean for maxilla intercanine distance was 30.0464 mm for males and 29.5442 mm for females; the inter 1st molar distance mean was 41.4652 mm for males and 41.2442 mm for females; the inter 2nd molar distance mean was 45.5177 mm for males and 45.1634 mm for females; the intercanine depth mean was 7.9141 mm for males and 7.5589 mm for females; the inter 1st molar depth mean was 31.5948 mm for males and 31.3941 mm for females; and the inter 2nd molar depth mean was 41.9125 mm for males and 41.6936 mm for females; on other hand, for mandibular arch the intercanine distance mean was 23.3118 mm for males and 22.2170 mm for females; the inter 1st molar distance mean was 36.0634 mm for males and for 35.2048 mm for females; the inter 2nd molar distance mean was 41.0913 mm for males and 40.4831 mm for females; the intercanine depth mean was 5.2461 mm for males and 5.0477 mm for females; the inter 1st molar depth mean was 26.6304 mm for males and 25.8830 mm for females; and the inter 2nd molar depth mean was 36.7454 mm for males and 36.0684 for females, as shown in Tables 3 and 4.

A cluster analysis was performed for dental arch forms, and all subjects were assigned to a cross-organizational table poised of maxillary and mandibular clusters, and from which, the group that has the highest percentage of samples (also representing the dominant arch form) is determined.

The use of K-means analysis is to find how many clusters are from the data according to iteration and to find the final center of clusters.

For the change in cluster centers for maxillary males, the current iteration is 5, and the minimum distance between initial centers is 4.619; for the change in cluster centers

Table 3: Descriptive statistics of maxillary arch

	Gender	Mean	Minimum	Maximum	SD	*P*
Intercanine distance	Male	30.0464	28.73	31.83	0.63039	0.00
	Female	29.5442	27.28	30.81	0.80688	
Inter first molar distance	Male	41.4652	39.31	43.01	0.86862	0.13
	Female	41.2442	39.22	42.31	0.71964	
Inter second molar distance	Male	45.5177	44.12	46.93	0.80640	0.01
	Female	45.1634	44.02	46.62	0.69126	
Intercanine depth	Male	7.9141	7.22	8.73	0.35322	0.00
	Female	7.5589	6.72	7.98	0.34420	
Inter first molar depth	Male	31.5948	30.08	33.13	0.81493	0.17
	Female	31.3941	29.83	32.83	0.77680	
Inter second molar depth	Male	41.9125	40.11	43.82	0.80661	0.12
	Female	41.6936	40.03	42.99	0.73121	

Note: $P \leq 0.05$

Table 4: Descriptive statistics of mandibular arch

	Gender	Mean	Minimum	Maximum	SD	*P*
Intercanine distance	Male	23.3118	21.39	24.83	0.83281	0.00
	Female	22.2170	21.34	23.49	0.50489	
Inter first molar distance	Male	36.0634	33.92	37.72	0.78061	0.00
	Female	35.2048	33.72	36.18	0.62185	
Inter second molar distance	Male	41.0913	39.34	42.26	0.68471	0.00
	Female	40.4831	39.04	41.83	0.73148	
Intercanine depth	Male	5.2461	4.63	5.92	0.32070	0.00
	Female	5.0477	4.52	5,49	0.21033	
Inter 1st molar depth	Male	26.6304	25.02	27.94	0.72289	0.00
	Female	25.8830	24.75	26.92	0.52254	
Inter 2nd molar depth	Male	36.7454	35.32	37.98	0.55726	0.00
	Female	36.0684	35.11	36.98	0.49826	

Note: $P \leq 0.05$

for mandibular males, the current iteration is 4, and the minimum distance between initial centers is 4.377; for the change in cluster centers for maxillary females, the current iteration is 9, and the minimum distance between initial centers is 3.802; and for the change in cluster centers for mandibular females, the current iteration is 4, and the minimum distance between initial centers is 2.815, as shown in Table 5.

The depth/distance ratio of each group was found in each arch form of each group by Rabirin *et al*.[16] (1993), as shown in Table 6.

So, according to Rabirin *et al.* (1993):

For upper males:

1st cluster (no. = 14) (representing 25%) is mid-form due to the three ratios = mean

2nd cluster (no. = 33) (representing 58.9%) is narrow due to the three ratios < mean

3rd cluster (no. = 9) (representing 16.1%) is wide due to the three ratios > mean.

So, from the result, we found that the narrow form is most commonly followed by the mid form and then the wide form, as shown in Table 7.

For upper females:

1st cluster (no. = 27) (representing 42.1%) is narrow due to the three ratios < mean

2nd cluster (no. = 17) (representing 26.5%) is wide due to the three ratios > mean

3rd cluster (no. = 20) (representing 31.2%) is mid-form due the three ratios = mean.

So, from the result, we found that the narrow form is most commonly followed by the mid form and then the wide form, as shown in Table 8.

According to Rabirin *et al.* (1993), in the lower males:

1st cluster (no. = 11) (representing 19.6%) is wide due to the three ratios > mean

2nd cluster (no. = 13) (representing 23.2%) is narrow due to the three ratios < mean

3rd cluster (no. = 32) (representing 57.1%) is mid-form due to the three ratios = mean. So, from the result, we found that the mid-form is most commonly followed by the narrow form and then the wide form, as shown in Table 9.

Table 5: Iteration for both arches and genders

Iteration for male maxilla	1	2	3
1	1.646	1.957	1.865
2	0.196	0.123	0.143
3	0.147	0.028	0.273
4	0.000	0.047	0.185
5	0.000	0.000	0.000
Iteration for male mandible	**1**	**2**	**3**
1	1.489	1.475	1.676
2	0.137	0.339	0.127
3	0.218	0.000	0.073
4	0.000	0.000	0.000
Iteration for female maxilla	**1**	**2**	**3**
1	1.452	1.791	1.557
2	0.121	0.172	0.185
3	0.065	0.100	0.088
4	0.070	0.116	0.107
5	0.048	0.091	0.000
6	0.075	0.113	0.119
7	0.000	0.117	0.085
8	0.097	0.151	0.000
9	0.000	0.000	0.000
Iteration for female mandible	**1**	**2**	**3**
1	1.019	1.034	1.008
2	0.132	0.247	0.080
3	0.000	0.076	0.051
4	0.000	0.000	0.000

Table 6: Depth/distance ratio

The selected arch	Intercanine ratio	Inter first molar ratio	Inter second molar ratio	Sum
Upper male	0.263	0.761	0.920	1.944
Lower male	0.225	0.738	0.894	1.857
Upper female	0.244	0.753	0.925	1.922
Lower female	0.277	0.735	0.890	1.852

Table 7: Properties of clusters of upper male arch

Variable	Cluster 1 (no. =14)	Cluster 2 (no. =33)	Cluster 3 (no. =9)
Percentage	25%	58.9%	16.1%
Intercanine distance	29.73	29.96	30.85
Inter first molar distance	40.44	41.69	42.25
Inter second molar distance	44.55	45.70	46.35
Intercanine depth	7.73	7.93	8.15
Inter first molar depth	30.88	32.07	30.98
Inter second molar depth	41.04	42.46	41.26
Intercanine depth/distance ratio	0.260	0.264	0.264
Inter first molar depth/distance ratio	0.763	0.769	0.733
Inter second molar depth/distance ratio	0.921	0.929	0.890
Sum of the three ratios	1.944	1.962	1.887

According to Rabirin *et al*. (1993), in lower females:

1st cluster (no. = 21) (representing 32.8%) is mid-form due to the three ratios = mean

2nd cluster (no. = 17) (representing 26.5) is wide due to the three ratios > mean

3rd cluster (no. = 26) (representing 40.6%) is narrow due to the three ratios < mean.

So, from the result, we found that the narrow form is most commonly followed by the mid form and then the wide form, as shown in Table 10.

The resulting forms of the arch of males and females are shown in Figures 5 and 6, respectively, whereas Figure 7 shows the drawing of the arch using the AutoCAD software, and Figure 8 shows the scheme illustrating the distribution of each form in each arch and each gender.

Discussion

Despite many studies of the labial arch form of the (X) population, there are limited studies regarding the lingual arch form of the (X) population, and limited data were available concerning the dimensions and ratios of population "norms." It means that all races and genders are subject to the influence of changes in all environmental and genetic factors that produce different developmental features and exhibit many variations in the shape and size of a dental arch, but it is still worth to handle a study to produce a normative value of the maxillary and mandibular lingual arch forms and dimension so it will be a normative baseline data for future studies concerning (X) population.

The selected age for examination at the mean that the selected age sample of this retrospective study was (18-24)

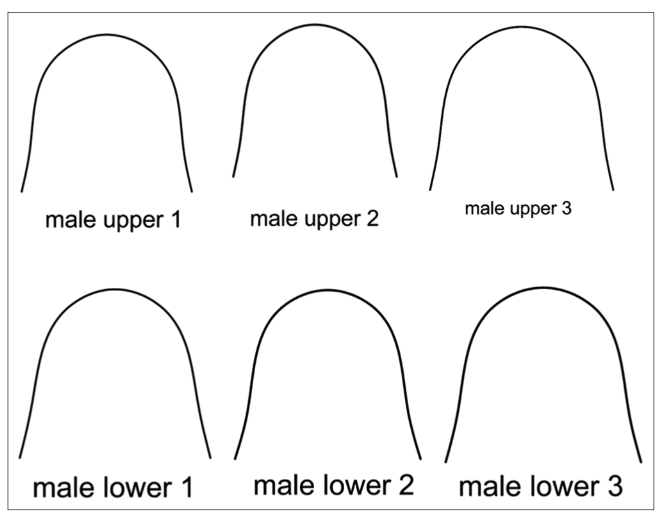

Figure 5: Upper and lower male arch form

Table 8: Properties of clusters of upper female arch

Variable	Cluster 1	Cluster 2	Cluster 3
Cluster size number and percentage	(no. =27) (represent 42.1%)	(no. =17) (represent 26.5%)	(no. =20) (represent 31.2%)
Intercanine distance	29.26	29.28	27.91
Inter first molar distance	41.10	40.66	40.66
Inter second molar distance	44.14	44.24	44.12
Intercanine depth	6.96	6.85	6.89
Inter first molar depth	31.08	30.35	30.75
Inter second molar depth	41.47	40.34	40.45
Intercanine depth/distance ratio	0.237	0.233	0.246
Inter first molar depth/distance ratio	0.756	0.746	0.756
Inter second molar depth/distance ratio	0.939	0.911	0.916
Sum	1.932	1.890	1.918

Table 9: Properties of clusters of lower male arch

Variable	Cluster 1	Cluster 2	Cluster 3
Cluster size number and percentage	(no. =11) (represent 19.6%)	(no. =13) (represent 23.2%)	(no. =32) (represent 57.1%)
Intercanine distance	22.50	22.83	23.79
Inter first molar distance	36.03	35.04	36.49
Inter second molar distance	40.94	40.27	41.48
Intercanine depth	5.04	5.19	5.34
Inter first molar depth	25.59	26.83	26.91
Inter second molar depth	36.16	36.57	36.98
Intercanine depth/distance ratio	0.224	0.227	0.224
Inter first molar depth/distance ratio	0.710	0.765	0.737
Inter second molar depth/distance ratio	0.904	0.910	0.891
Sum of the three ratios	1.838	1.902	1.852

Table 10: Properties of clusters of lower female arch

Variable	Cluster 1	Cluster 2	Cluster 3
Cluster size number and percentage	(no. =21) (representing 32.8%)	(no. =17) (representing 26.5)	(no. =26) (representing 40.6%)
Intercanine distance	21.95	22.30	22.37
Inter first molar distance	35.06	35.73	34.98
Inter second molar distance	41.08	40.83	39.77
Intercanine depth	5.02	5.06	5.06
Inter first molar depth	26.27	25.44	25.98
Inter second molar depth	36.35	35.77	36.04
Intercanine depth/distance ratio	0.228	0.226	0.226
Inter first molar depth/distance ratio	0.749	0.712	0.739
Inter second molar depth/distance ratio	0.880	0.876	0.906
Sum	1.857	1.814	1.871

(SD 1.84) because all permanent teeth had erupted (wisdom teeth not included) also because the arch width shows no significant growth at this age period (especially maxillary canine depth showed a significant decrease between 13 to 17 years of age groups).[17]

In the current study, for all dimensions and records, it is obvious that the arch length and width of the maxillary arch are larger in all dimensions when compared with the mandibular arch and confirmed the principle that the upper dental arch generally overlaps the lower dental arch.[18] The sex difference characteristic of arch form found that there is a significant difference between males and females taking into consideration that male dimensions are larger in all when compared to the female dimensions in both length and width measurements. Lambardo *et al*., 2010,[11] disagree with the current study that assigns no significant difference between males and females in length and width dimensions. In the maxilla, the results of intercanine distance show significantly larger mean values in males compared with females and that is akin to the finding by the study of N. Zhou[19]; the intercanine depth in the maxillary arch shows significantly larger mean values in males compared with females and that finding agrees with the results of Raberin *et al*.[16] and Ferrario *et al*.[20] that there is sex dimorphism between males and females and that male intercanine depth

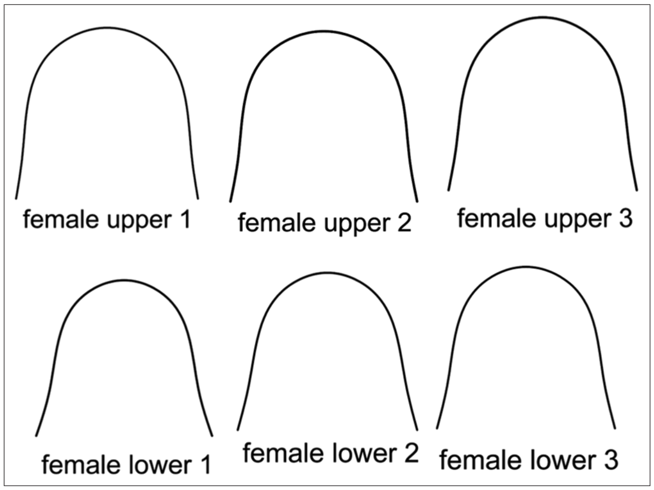

Figure 6: Upper and lower female arch form

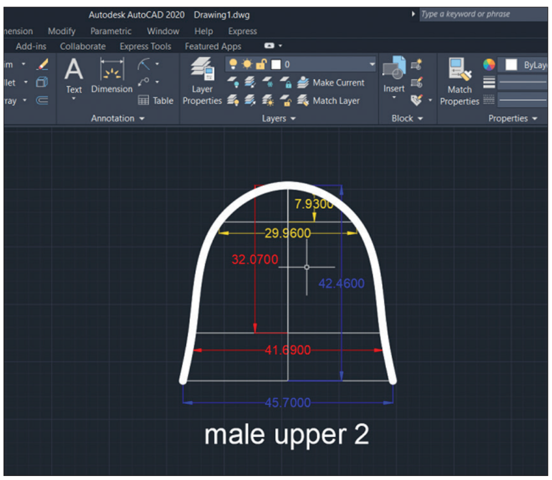

Figure 7: Drawing of arch form depending on the resulted points using the AutoCAD program

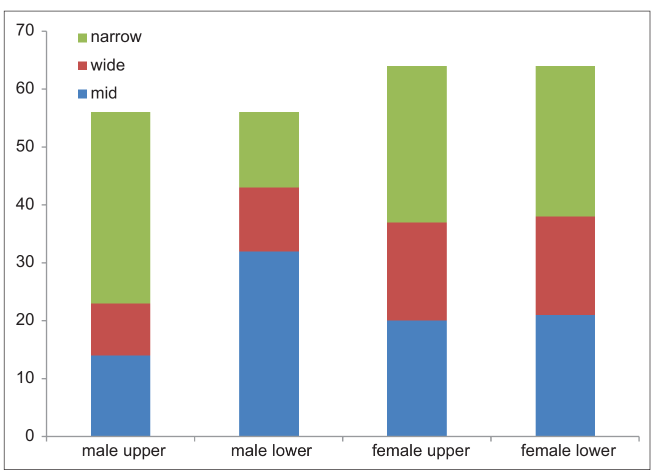

Figure 8: Scheme illustrating the distribution of each form in each arch and each gender

is larger in males than in females. The inter 1st molar distance results show nonsignificant differences in the mean values of males compared with females, and this disagrees with the findings of studies of Chen *et al*.[19] and Ferrario *et al*.[20]

The results of inter 1st molar depth show nonsignificant larger mean values in males compared with females, and these results show that males have longer arches than females, which settles with the study of Raberin *et al*.[16]

In the current study, the inter 2nd molar distance results show significantly larger mean values in males compared with females, and the wider arches in males, when compared with females, are similar to the result of Ferrario *et al*.,[20] while the inter 2nd molar depth outcome shows a larger mean value in males compared with females, which indicates that males have a longer and wider arch than females and that looks like the result of Raberin *et al*.[16] In the mandible, the intercanine distance results show significantly larger mean values in males compared with females, and this relationship agrees with that was found in the study of Ferrario *et al*.,[20] regarding the intercanine depth results, and there is a significantly larger mean value in males compared with females, which disagrees with the outcome of Lombardo *et al*.[11] who found no significant difference between male and female results, which are due to ethnic variation, number of the samples, and differences in calibration method.

The inter 1st molar distance outcome shows significantly larger mean values in males compared with females. This finding is comparable to the finding of Lara-Carrillo *et al*.[21] in the Mexican population. Regarding the depth of inter 1st molar, there is a significantly larger mean value in males compared with females. These results disproportion the study of Lombardo *et al*.[11] who found no substantial difference between males and females. The inter 2nd molar distance upshots show significantly larger mean values in males compared with females, and this finding is comparable to the finding of Lara-Carrillo *et al*.[21] in the Mexican population.

Regarding the inter 2nd molar depth results, there is a larger mean value in males compared with females, which is comparable to the finding obtained by Bishara *et al*.[22] and disagrees with the study of L. Lombardo *et al*.[11] who found an insignificant difference between males and females, which can be inferred also from the difference in the ethnic group, sample numbers, and variation in the calibration procedure.

Correlation coefficient were mean The possible range of values for the correlation coefficient is -1.0 to 1.0. In other words, the values cannot exceed 1.0 or be less than -1.0. A correlation of -1.0 indicates a perfect negative correlation, and a correlation of 1.0 indicates a perfect positive correlation.[15]

In the maxillary arch, there is a positive correlation between all dimensions as shown in Tables 8 and 11 and this agrees with the results conducted by Tarfa, S. J. (2021) and Kareem *et al*.,[23,24] while for the mandibular arch there is a positive correlation between all dimensions as shown in Tables 9 and 12 and this agrees with the results conducted by Tarfa, S. J. (2021) and Soni *et al*.[24,25]

The negative correlation in the upper arch (the intercanine distance and the inter 2nd molar depth) and in the lower arch (the intercanine distance and the inter 1st molar depth) can be attributed to greater variability in the intercanine distance and the least variability in the intermolar distance (1st and 2nd) in addition to sex variation and age group of the sample and continuous growth of the intercanine and intermolar (1st and 2nd) distances in males greater than the females.[26]

Conclusion

Three arch forms have been contrived for both maxillary and mandibular lingual arches (mid, wide, and narrow), which can be used as pattern guide for the construction of lingual arch wires for (X) orthodontic patients and are considered more useful for the clinical selection of mandibular and maxillary lingual super elastic wires. There was a statistically substantial difference in the size of arch form dimensions in both length and width between male and female dental patients.

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Conflicts of interest

There are no conflicts of interest.

Table 11: Ratio of maxillary arch

	Male	Female
Canine depth distance/intercanine distance	0.263	0.244
First molar depth distance/inter first molar distance	0.761	0.753
Second molar depth distance/inter second molar distance	0.920	0.925

Table 12: Ratio of mandibular arch

	Male	Female
Canine depth distance/intercanine distance	0.225	0.277
First molar depth distance/inter first molar distance	0.738	0.735
Second molar depth distance/inter second molar distance	0.894	0.890

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