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Determinant factors of Yemeni maxillary arch dimensions

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Abstract *Objective:* Information about maxillary arch and palatal dimensions in human populations is important for clinical orthodontics. This study was conducted to assess the determinants of maxillary arch dimensions in a sample of Yemeni individuals aged 18–25 years.

Materials and Methods: The study sample comprised 214/765 adults (101 women, 113 men) who underwent clinical examination and fulfilled the study criteria. Study models were constructed and evaluated to measure maxillary arch and palatal dimensions.

Results: The majority of mean maxillary arch dimensions were significantly greater in men than in women, with inter–second molar distance showing the greatest difference and palatal depth showing the least difference.

Conclusion: Measurements of palatal depth and relationships of the canines to one another and to other teeth thus had the widest ranges, implying that these dimensions are the strongest determinants of maxillary arch size.

1. Introduction

Dental arch size and form vary among individuals according to tooth size and position, craniofacial growth pattern, and several genetic and environmental factors (Ferrario et al., 1994; Harris and Smith, 1982).

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A survey of dental arch size and form could aid clinicians' selection of stock trays, artificial tooth sizes, and artificial dental arches used as wax mock-ups and modified by dental surgeons and orthodontists (Knott, 1961; Mack, 1981).

Given its morphology and position, the palate is a key anatomical structure determining skeletal patterns. The palate can be affected by orthodontic treatment (Harris and Smith, 1982).

As orthodontics has advanced as a specialty, increasing numbers of adults seek orthodontic care. Thus, an understanding of the changes that normally occur in adult craniofacial structures is critical (Bishara et al., 1989).

Orthodontic practice and education remain relatively new in Yemen. A systematic and well-organized dental care program for any target population requires basic information, such as the prevalence of dental conditions. In the more

developed parts of the world, where orthodontics has been established, adequate baseline information is available (Barrow and White, 1952; Bishara et al., 1997, 1998; Buschang et al., 1994; Lavelle et al., 1971; Mills, 1964; Raberin et al., 1993; Warren and Bishara, 2001).

Despite efforts in recent decades to make health systems more equitable in the Arab world (Al-Khateeb and Abu Alhaija, 2006; Diwan and Elahi, 1990; Eid et al., 1987; Ismail et al., 1996; Younes, 1984), access to dental health care remains far from adequate, especially in poor communities.

No previous study has examined maxillary arch or palate dimensions in the Yemeni population. Thus, this study was conducted to provide baseline data on these dimensions in Yemeni adults aged 18–25 years.

2. Materials and methods

The Ethics Committee of the Faculty of Dentistry, University of Sana'a, Yemen, approved this study. The study design and purpose were explained to all potential participants, who provided consent prior to participation.

The study sample comprised 214 adults (113 men, 101 women) aged 18–25 years selected from a population of 765 Yemeni adults (387 men, 378 women) who had undergone clinical examination. Eligible subjects met the following criteria:

1. complete permanent dentition (excluding third molars)
2. class I molar and canine occlusion (Angle, 1889; Houston et al., 1996)
3. class I skeletal relationship, determined visually using the two-finger technique (Mills, 1987)
4. absence of local factors that compromised dental arch integrity (e.g., congenitally absent teeth, deciduous tooth retention, supernumerary teeth)
5. normally shaped teeth
6. normal vertical and horizontal dental relationships (no overjet or overbite)
7. absence of large fillings that may affect dental arch size and form
8. no previous orthodontic, orthopedic, or facial surgical treatment
9. well-aligned arches with < 3 mm space and no crowding (Staley et al., 1985)
10. no history of bad oral habits, such as thumb sucking or mouth breathing.

All individuals were examined under natural light with interchangeable plane mouth mirrors. During examinations, each individual was seated on an ordinary chair with the head positioned so that the Frankfort horizontal plane was parallel to the floor.

Selected individuals underwent thorough clinical examination to ensure fulfillment of the inclusion criteria.

Certain tooth-related points visible in occlusal view were marked bilaterally with a sharp pencil on maxillary study casts to facilitate the identification of landmarks used to measure dental arch dimensions. Great care was taken to ensure that the landmarks were located accurately on the study casts.

Measurements were recorded on 214 maxillary casts made of dental stone, with bases made of plaster of Paris. The bases were trimmed as in orthodontics and numbered to correspond to study subjects. Dental arch dimensions and palatal length and width were measured using a modified sliding caliper gauge (accurate to 0.02 mm). Palatal depth was measured using a palatometer.

2.1. Landmarks

The following landmarks were used:

1. incisal point: the point midway between the incisal edges of the two central incisors (Younes, 1984)
2. canine cusp tips: the cusp tips of the right and left permanent canines (Staley et al., 1985)
3. premolar cusp tips: the buccal cusp tips of the right and left second premolars (Bishara et al., 1989)
4. mesiobuccal first molar cusp tips: the mesiobuccal cusp tips of the right and left permanent first molars (Kuntz, 1993)
5. mesiolingual first molar cusp tips: the mesiolingual cusp tips of the right and left permanent first molars (Ghafari et al., 1994)
6. distobuccal second molar cusp tips: the distobuccal cusp tips of the right and left permanent second molars (Raberin et al., 1993).

2.2. Maxillary arch width (Fig. 1)

1. intercanine distance: the linear distance between canine cusp tips
2. interpremolar distance: the linear distance between the buccal cusp tips of the second premolars
3. inter–first molar distance: the distance between the mesiobuccal cusp tips of the first molars
4. inter–second molar distance: the distance between the distobuccal cusp tips of the second molars.

2.3. Maxillary arch length (Fig. 2)

1. anterior arch length: the vertical distance from the incisal point to the intercanine distance line
2. molar-vertical distance: the vertical distance from the incisal point perpendicular to a line between the mesiolingual cusp tips of the first molars
3. total arch length: the vertical distance from the incisal point to the midpoint of a line between the distobuccal cusp tips of the second molars.
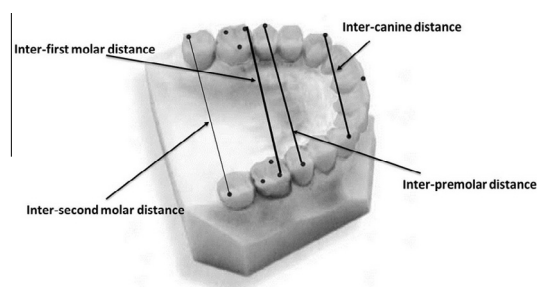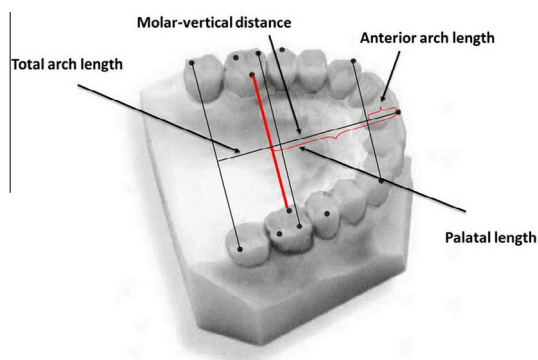

Figure 1 Maxillary arch width.

Figure 2 Maxillary arch and palatal length.

2.4. Palatal width, length, and depth (Fig. 3)

1. palatal width: the linear distance between the mesiolingual cusp tips of the right and left first molars
2. palatal length: equivalent to the molar-vertical distance
3. palatal depth: the vertical distance from a point on the palatal width line to the palatal vault in the midline.

2.5. Statistical analysis

All statistical analyses were performed using SPSS software (version 13.0; SPSS Inc., Chicago, IL, USA). Descriptive
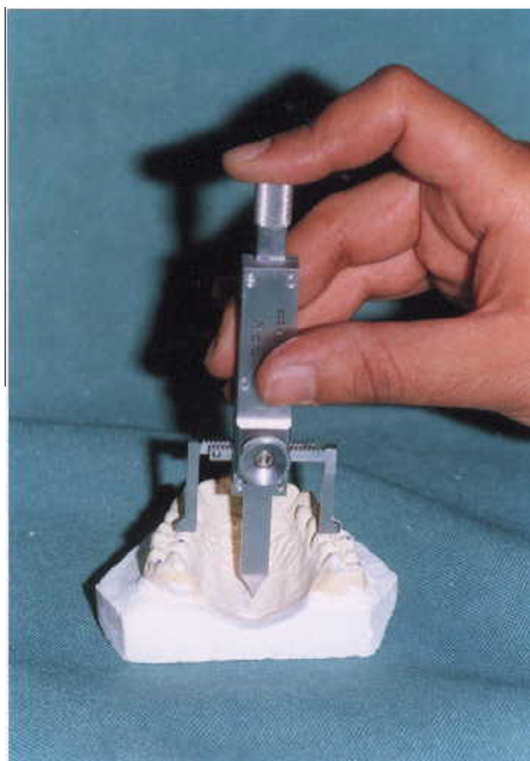

Figure 3 Measurement of palatal width and depth by Palatometer.

statistics were obtained by calculating mean, minimum, and maximum values; standard deviations; ranges; and coefficients of variation (CVs). Differences in palatal and maxillary arch dimensions between men and women were examined using t-tests. P values < 0.05 were considered to be significant.

3. Results

Maxillary and palatal dimensions are shown in Table 1. The inter–second molar distance had the widest range.

Dimensions are presented according to sex in Table 2. The majority of mean maxillary arch values were significantly larger in men than in women, with the inter–second molar distance showing the greatest difference and palatal depth showing the least difference. Mean molar-vertical distance and palatal length were significantly greater among women than among men.

Correlation coefficients between arch widths and lengths were calculated. Some measurements of arch width and length were significantly, positively, and directly correlated, whereas others showed moderate, weak, and/or negative correlation. Maxillary arch dimensions were correlated more strongly in women than in men (Table 3).

4. Discussion

4.1. Sample selection

Oral health, particularly the treatment of malocclusion, is not currently a high priority in Yemen. However, for future planning purposes, valid and reliable information about norms (normal skeletodental relationships) is needed. Such information enables the establishment of useful guidelines for orthodontic diagnosis and treatment planning.

Dental arch integrity can be disturbed by many local factors affecting dental arch size and form, such as heavy fillings, spacing or crowding, abnormally shaped teeth, and bad oral habits (e.g., thumb sucking or mouth breathing). Individuals affected by any of these factors were excluded from participation in the present study.

Although precise skeletal relationships can be determined using lateral cephalometric radiographs, the ability to assess these relationships clinically is important due to the unavailability of cephalometric equipment in many practices. The two-finger technique of skeletal pattern assessment has been validated (Mills, 1987; Singh, 2007; Cobourne and DiBiase, 2010).

4.2. Sex differences

As confirmed in many previous studies, maxillary arch widths were greater in men than in women in the present study. Clinicians have speculated that women have smaller bony ridges and alveolar processes and the average weakness of musculature males, which have important effects on measurements of facial breadth and dental arch height and width, and the later growth period in males than females (Younes, 1984).

The observation of significant sex differences only in transverse dimensions is in agreement with many previous reports (Cohen, 1940; Moorrees and Reed, 1965;; Alvaran, 2009) and contrasts with reports with nearly similar maxillary widths in men and women (Knutz 1993). Ismail et al. (1996) reported a greater width in females than in males, but this difference

Table 1 Maxillary arch widths and lengths for the total sample.

	Mean[a]	S.D.	Min.	Max.	Range
Inter-canine distance	34.2	2.04	30.0	39.0	9.0
Interpremolar distance	46.4	2.6	40.0	52.0	12.0
Inter-first molar distance	51.2	2.7	44.0	57.3	13.3
Inter-second molar distance	56.9	3.3	49.4	64.7	15.3
Anterior arch length	8.7	1.2	5.0	11.4	6.4
Molar-vertical distance	30.0	2.1	24.9	34.9	10.0
Total arch length	42.6	2.4	38.4	47.6	9.2

[a] Measurements are in mm.

Table 2 Maxillary arch and Palatal dimensions according to gender.

	Females n = 101			Males n = 113			T-value
	Mean [a]	S.D.	C.V	Mean	S.D.	C.V	
Inter-canine distance	33.27	1.78	5.86	35.06	1.89	5.40	6.29[**]
Inter-premolar distance	45.41	2.32	5.10	47.29	2.45	5.19	4.97[**]
Inter-first molar distance	49.94	2.19	4.39	52.53	2.62	4.99	6.93[**]
Inter-second molar distance	55.27	2.82	5.10	58.51	3.03	5.18	7.15[**]
Anterior arch length	8.54	1.35	15.76	8.88	1.08	12.19	1.81
Molar-vertical distance	30.39	2.12	6.69	29.71	2.02	6.79	2.13[**]
Total arch length	42.30	2.43	5.74	42.62	2.32	5.43	0.86
Palatal width	39.06	2.32	5.93	41.66	2.82	6.77	6.49[**]
Palatal length	30.42	2.04	6.70	29.73	2.01	6.75	2.21[**]
Palatal depth	20.71	1.39	6.73	21.17	1.51	7.12	2.04[**]

[a] Measurements are in mm.
[**] Statistically significant ($p < 0.05$).

Table 3 Correlation Coefficient between the Maxillary widths and lengths.

	Anterior arch length		Molar-vertical distance		Total arch length	
	F	M	F	M	F	M
Inter-canine distance	0.47	0.13	0.35	-0.11	0.30	-0.07
Inter-premolar distance	0.62	0.15	0.38	0.09	0.30	0.11
Inter-first molar distance	0.56	0.20	0.32	0.01	0.24	0.10
Inter-second molar distance	0.18	-0.12	0.24	0.21	0.10	0.05

Values more than 0.21 were significant at $p < 0.05$.

was not statistically significant. In the present study, the inter–second molar distance showed the largest difference between sexes, which may be attributed to the difference in arch form.

In contrast with the findings of Raberin et al. (1993) and Borgan (2001), no sex difference in anterior or total maxillary arch length was observed in this study.

Mean molar-vertical distance and palatal length were greater in women than in men, contradicting the accepted view that maxillary arch dimensions are larger in men. Cohen (1940) reported similar results. This difference may be attributable to differences in ethnicity, sample size, tooth size (women have larger teeth), and/or environmental factors.

The observed greater palatal width and depth in men than in women is in agreement with the findings of Borgan (2001) and contrasts with the absence of a sex difference in these dimensions reported by Al-Mulla et al. (1997).

4.3. Determinants of Yemeni maxillary arch dimensions

Correlations between all maxillary dental arch widths and lengths were weak in men, but most correlations (except that between inter–second molar distance and total arch length) were strong in women.

CV values for all measurements of maxillary arch width and length were nearly close to each other, with intercanine distance and anterior arch length, respectively, producing the largest CVs among these values. These results are to be expected, as these two dimensions contribute to differences in arch form. These findings are in agreement with those of Andria and Carlos (1978).

CV values for all palatal measurements were also nearly close to each other, with palatal depth showing the largest CV.

Measurements of palatal depth and relationships of the canines to one another and to other teeth thus had the widest ranges, implying that these dimensions are the strongest determinants of maxillary arch size.

5. Conclusion

- Maxillary arch width was greater in Yemeni men than in women, whereas molar-vertical distance and palatal length were greater in Yemeni women than in men.
- Measurements related to the canines and palatal depth had the widest ranges implying that these dimensions are the strongest determinants of maxillary arch size.

Conflict of interest

The author declare no conflict of interest.

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