

THE RELATIONSHIP BETWEEN MANDIBULAR ARCH LENGTH AND WIDTH

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ABSTRACT

Objective: To determine the relationship between mandibular arch length and widths in a sample of Peshawar population.

Material and Methods: A total of 92 casts were selected from the Department of Orthodontics. The intercanine, inter-first molar, and mandibular arch length were measured on casts. All statistical analyses were performed using SPSS 16 software (SPSS Inc., Chicago, Ill, USA). Descriptive statistics were performed for the calculation of the mean, standard deviation, minimum, maximum, and range. The t-test was applied to test the level of significance between the mean for males and females for all mandibular arch dimension. The Spearman's correlation coefficient (r) was also calculated between the measurement of arch widths and lengths in female and males. Statistical significance was predetermined at the 95% level at ($P < 0.05$).

Results: Out of 92 patients, 50% were males and 50% were females. The age ranged from 14 to 30 years with mean age of 15 ± 2.1 years. The mean value for Inter canine, Inter-First molar distance, Total arch length was 26.3, 45.3, and 37.7. Intermolar distances were greater than intercanine distances; proving tapered arch form. Gender wise comparison showed that intermolar distance was statistically significantly different having p-value less than 0.05. Differences for intercanine and arch length were not significant statistically with a p-value higher than critical value. The correlation coefficient for intercanine and mandibular arch length was higher in females (0.6) than males (0.44). The correlation coefficients for intermolar and mandibular arch length were nearly equal in females (0.28) and males (0.2).

Conclusions: Tapered arch form in mandible is common in this sample of Peshawar population. A weak correlation exists between arch length and width in mandible.

Key words: Arch width, Arch length, Inter canine width, Inter molar width

INTRODUCTION

Ideal arch form to suit every individual has been the focus of several reports, and varies in form and shape in individuals based on anatomic dimensions of the craniofacial skeleton¹. Qualitative description of the dental arch use terms like elliptic, parabolic or U-shaped; whereas mathematical methods include several curve-fitting algorithms like parabola, semi ellipse, catenary's curve, conic section, cubic plane curve and second to eighth order polynomials². Despite the huge efforts and research works done to determine the ideal arch form, there is little agreement among investigators

about the natural shape of the dental arches³.

Hawley⁴, based on the earlier work of Bonwill⁵ described the ideal arch as being constructed upon an equilateral triangle with slight modifications. The six anterior teeth were thought to be arranged on the arc of a circle whose radius was determined by the combined width of incisors and canines, with the premolars and first permanent molars arranged in a straight line and the second and third molars turning towards the midline. Catenary arch design depends on inter-molar distance measured at central fossae, it could be described as a central core around which the teeth arrange themselves⁶. Brader⁷ proposed that the dental arch is best considered as a closed curve with the properties of a trifocal ellipse with the teeth occupying only the narrower end of the total curve.

The width, length and depth of dental arches

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have had considerable implications in orthodontic diagnosis and treatment planning in a modern dentistry based on prevention and early diagnosis of oral disease⁸. These dental arch dimensions systematically change during the period of intensive growth and development, but lessen at adulthood⁹. Because of this, many studies have investigated arch dimensional changes in various stages of growth and development, such as arch width and arch dimensions^{10,11}.

The size and form of the dental arches also vary among individuals according to tooth size, tooth position, pattern of craniofacial growth and by several genetic and environmental factors¹². Survey of arch size could help clinicians in the selection of stock trays, the size of artificial teeth, and the overall forms of artificial dental arch at the wax trial stage are amenable to modification by the dental surgeon and in orthodontic treatment¹³. As orthodontics has advanced as a specialty and the number of adults seeking orthodontic care has increased, an understanding of the changes that normally take place in adult craniofacial structures becomes critical¹⁴.

The objective of this study was to determine the relationship between mandibular arch length and widths in a sample of Peshawar population.

METHODS AND MATERIALS

A retrospective cross-sectional study was conducted from 1st July 2014 to 15th January 2015. Ninety-Two casts of both male and females with age ranging from 14 to 30 years were included in the study. Dental casts were taken from the records of patients in Department of Orthodontics, Khyber College of Dentistry, Peshawar. Cast related to patient with, full complement of normal shaped permanent teeth (excluding third molars), Class I molar and canine relationships, Class I skeletal relationship, normal vertical and horizontal dental relationships (normal overjet and overbite) and well aligned arches with less than 3 mm of spacing or crowding in either arch were excluded in this study.

Those cases who had teeth with heavy fillings, congenital missing teeth, retained deciduous, and supernumerary teeth, previous orthodontic, orthopedic, facial surgical treatments and history of bad oral habits such as thumb sucking or mouth breathing were excluded from the study.

Certain selected tooth-related points visible in an occlusal view were marked bilaterally with a sharp

pencil in the mandibular study casts. Great care was taken to ensure that the landmarks were accurately located on the study casts. Measurements were taken from 92 mandibular dental casts, which were made of dental stone, with the base, made of plaster of Paris. Dental arch dimension measurements were carried out using the digital caliper gauge, which is accurate up to 0.01 mm. The linear distance from cusp tip of one canine to the cusp tip of the other was measured for inter canine distance while the distance from the mesiobuccal cusp tip of one first permanent molar, to the mesiobuccal cusp tip of the other for inter first molar distance. The vertical distance from the incisal point to the midpoint of a line joining the disto-buccal cusp tip of the second permanent molars was determined for total arch length.

Sample size was calculated using National Council for Social Studies, Powerful and Authentic Social Studies (NCSS PASS 2011; www.ncss.com) for Spearman correlation. A sample size of 92 would achieve an 90 per cent power below the alternative hypothesis correlation of 0.333 using a two-sided hypothesis test with a significance level of 0.05.

Thirty casts were measured for mandibular length and arch width by two experienced examiners. To determine the consistency of measurements, 2 researchers measured 30 casts separately. The interobserver correlation coefficient was used to determine the consistency of the measurement. A high correlation coefficient of 0.98 was obtained. Paired student t tests with a significance level of 5% were used to compare the differences between two observers. The result showed no difference ($p=0.455$).

All statistical analyses were performed using SPSS 16 software (SPSS Inc., Chicago, Ill, USA). Descriptive statistics were performed for the calculation of the mean, standard deviation, minimum, maximum, and range. The t-test was applied to test the level of significance between the mean for males and females for all mandibular arch dimension. The Spearman's correlation coefficient (r) was also calculated between the measurement of arch widths and lengths in female and males. Statistical significance was predetermined at the 95% level at ($p < 0.05$).

RESULTS

Out of 92 patients, 50% were males and 50% were females. The age ranged from 14 to 30 years with mean age of 15 years $\pm$ 2.1 SD. The mean value for Inter canine, Inter-First molar distance, Total arch length was 26.3, 45.3, and 37.7 respectively. Intermo-

lar distances were greater than intercanine distances; proving tapered arch form. The details are given in Table 1.

Gender wise comparison showed that intermolar distance difference was significant statistically having p-value less than 0.05. Differences for intercanine and arch length were not significant statistically with a p-value higher than critical value. The details are given in Table 2.

The correlation coefficient for intercanine and mandibular arch length was higher in females (0.6) than males (0.44). The correlation coefficients for intermolar and mandibular arch length were nearly equal in females (0.28) and males (0.2). The details are given in Table 3.

DISCUSSION

Dental arch form is a fundamental parameter in orthodontic diagnosis and the subsequent formulation of a treatment plan, due to its influence on available space and smile aesthetics. Furthermore, the post-treatment arch form is highly influential on long-term occlusal stability¹⁵. However, the extreme individual variability of this factor makes an ideal arch form rather difficult to describe. In fact, numerous studies have reported differences in both form and size between races, individuals from similar ethnic backgrounds, and males and female¹⁶. Moreover, the form of the arch is modified during growth, transition between mixed and permanent dentition, and over time, irrespective of whether orthodontic treatment has been performed or not. The arch form is determined by intercanine and intermolar distances. In tapered arch, the intercanine distance is less than intermolar distance while in square

Table 3: Relationship between the mandibular widths and lengths shown with the corresponding spearman correlation coefficients (r)

Mandibular arch Dimension	Total arch length		p-value
	Female(r) †	Male (r) †	
Inter-canine Distance	0.60*	0.44*	0.000
Inter First molar distance	0.28	0.20	0.095

* Significant level < 0.01

† Pearson coefficient of correlation

arch form both are equal¹⁷. In the present study the average value of arch width is tapered in mandible.

Previous studies demonstrated that the most common arch form is tapered in Caucasians (43.8%), square in Korean and Japanese people (46.7% and 45.6%, respectively), and ovoid in Israeli people (50.7%)¹⁶. Meanwhile, Bayome et al¹⁸ reported an even distribution of the arch forms in Egyptians.

In the present study the mandibular arch length, intercanine distance and intermolar distance were greater in males than females. This may be attributed to the smaller bony ridge and alveolar process of females, the average weakness of musculature in females that play an important role in facial breadth measurements, width and height of the dental arch³. According to Moss's functional matrix theory; the origin, development and maintenance of all skeletal units are secondary, compensatory and mechanically obligatory responses to temporally and operationally prior demands of related functional matrices (muscles)²⁰. Males growth period by average is 2 years longer than females and may be a factor in smaller sizes of dental arches and widths²¹.

Table 1: Mean and standard deviation (SD) of mandibular arch widths (mm) and lengths (mm)

Mandibular arch Dimension	Mean (SD)	Minimum	Maximum	Range
Intercanine distance	26.3(1.7)	22.1	28.3	6.2
Inter First molar distance	45.3(2.8)	38.0	50.4	12.4
Total arch length	37.7(2.9)	31.8	44.6	12.8

Table 2: Mandibular arch dimensions (mm) according to gender

Mandibular arch Dimension	Female n=46	Male n=46	T-value	p-value
	Mean (SD)	Mean (SD)		
Intercanine distance	26.3(1.7)	27.49 (1.61)	0.83	0.279
Inter First molar distance	41.91 (2.65)	45.09 (2.21)	6.4*	0.049*
Total arch length	37.7(2.9)	38.37 (2.22)	0.03	0.490

*statistically significant

The findings of this study showed statistically significant difference between males and females for some measurements, this confirms those results previously published by many investigators^{3,22}, while contradict other investigators²³. Kuntz²⁴ reported that both sexes had nearly similar inter-canine distance and Ismail et al²² reported that females had larger widths than males, but the difference was not statistically significant.

The Spearman's correlation coefficient (r) was calculated between the measurements of arch widths and lengths. Overall, the male group demonstrated greater transverse and sagittal mandibular dimensions; however, this was only statistically significant for measurements of inter-first and second molar distances and anterior arch length ($P < 0.05$). Relatively stronger linear relationships were observed between the inter-canine distance and mandibular arch lengths ($P < 0.05$, Spearman's r ranged between 0.17 to 0.50). Al-Zubair³ assessed the relationship between mandibular arch length and width in a sample of 214 Yemeni patients. Similarly they have shown that correlation coefficient is smaller for males as compared to females for both intercanine and first intermolar distances. These observations are in accordance with the results of the present study in which only first intermolar and intercanine widths were correlated with total arch length. Little literature is available on this subject to factors responsible for this. The highest correlation is being for females between arch length in mandible and intercanine width.

CONCLUSIONS

It is concluded from the results of the present study that tapered arch form in mandible is common in this sample of Peshawar population. A weak correlation exists between arch length and width in mandible.

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