

Relationship between Pterygomaxillary Notches, Maxillary Anterior Teeth and Dental Arch: An in vivo study

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Abstract

Original Research Article

Aims and Objectives: The aim of this study was to observe the relationship between the width of permanent maxillary anterior teeth with the dimensions of hard palate for the selection of appropriate mesiodistal width of artificial maxillary anterior teeth. **Materials and Methods:** This study was conducted on seventy individuals within the age group of 18-30 years. Both upper and lower dental casts were made. All the measurements were taken directly on the maxillary dental casts with a precise digital calliper. In all the seventy individuals the significance of the differences in the means and the ratios of means of arch dimensions and tooth measurements were calculated. **Results:** No statistically significant difference was found between the interhamular width/ distal maxillary arch width and the sum of the widths of maxillary anterior teeth. ($p > 0.05$ and $t < 1.96$). **Conclusions:** Interhamular width and distal maxillary arch width were found to be almost equal to the sum total mesiodistal dimension of maxillary anterior teeth. But after extraction of all teeth, distal maxillary arch width is lost which is not possible to reconstruct because of different rate of alveolar bone resorption. On the other hand, Interhamular width remains of the same dimension during lifetime. Therefore it can be concluded that measurements of Interhamular width could be a practical method for clinical application, for determination of sum total mesiodistal width of maxillary anterior teeth.

Key words: Interhamular width, distal maxillary arch width, frontal maxillary arch width.

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INTRODUCTION

One of the most confusing aspects of the complete denture prosthodontics is the selection of appropriately sized artificial maxillary anterior denture teeth. There is no consensus of data regarding a single esthetic factor that can be used reliably as an aid for artificial teeth selection during the denture construction [1,2]. The width of these teeth is considered a harder aspect to estimate than their height because the length of the upper lip and the smile line can be reliable anatomical parameters to select the height of the maxillary anterior teeth in order to avoid showing the denture base [3-6]. However, no reliable anatomic parameters are available to select the width of these teeth. Thus it is our mission, as a prosthodontist to preserve the natural dignity of advancing age while

fabricating the prosthesis, with precise selection of artificial teeth.

Various Methods have been used for selecting the size of anterior teeth which include: pre extraction records (such as photographs, radiographs, extracted teeth, study casts) and observation of the teeth of close relatives.

It has been considered by various authors [3, 7, 8] that pre- extraction records are a reliable guide for the selection of teeth. However, in the absence of pre-extraction records which is a frequent occurrence, it is very difficult to select an appropriate tooth mould that can re-establish the naturalness of the individual patient. Various intraoral and extraoral anatomic landmarks such as the incisive papilla, intercanthal distance,

interpupillary distance, interalar distance and intercommisural distance have been used as a guide for the selection of anterior teeth [1, 9-11]. However, there have been conflicting views on the values of such estimation.

The main problem of these biometric measurements that uses these soft tissue structures for artificial tooth selection is the absence of a static relationship of soft structures, as the width of soft tissues may change according to several factors such as aging, the weight and build of the person [12]. Therefore, a relationship between dimensions of the anterior teeth with anatomic landmarks can be drawn reliably only, when anatomic landmarks independent of such factors are used.

The Pterygomaxillary notch is the palpable notch formed by the junction of the maxilla and the pterygoid hamulus of the sphenoid bone and it does not change with factors such as weight changes, aging, and extraction of teeth. Pterygomaxillary notches can be easily identified on the dental casts, as well as intra orally and may be used as an alternative anatomical landmark for determining the width of anterior teeth. Data correlating dimensions of hard palate and maxillary anterior teeth is scarce in literature.

Therefore, a study was planned to determine, whether there was any relationship between tooth measurements [sum total mesiodistal width of maxillary anterior teeth (SMxAT), intercanine cusp tip width (ICTW) and circumferential arc distance from the distal surface of the canines (ARCD)] and arch dimensions [interhamular width (IHW), frontal maxillary arch width (FMAW) and distal maxillary arch width (DMAW)].

MATERIALS AND METHODS

Source of data

The study was conducted in the Department of Prosthodontics, Govt Dental College and Hospital Patiala. The study included seventy dentate individuals (males and females) who were undergraduates and postgraduates from Govt. Dental College and Hospital Patiala and from the Govt. Medical College Patiala within the age group of 18- 30 years, this age group was chosen ,as individuals at this age showed minimal attrition of teeth.

Method of collection of data

All patients were informed about the aim of the study and the methods to be used and written consent was obtained from each individual. The plan for this study was approved by the institutional ethical committee. The inclusion criteria of the subjects were as follows: the individuals with Angle class I maxillo-mandibular relationship, natural maxillary permanent teeth in good alignment (minimal tooth rotations and

compressions were allowed), no frontal tooth restoration or prosthetic appliance or tooth loss in maxilla (except 3rd molar) and no history of orthodontic treatment.

The exclusion criteria of subjects were as follows: interdental spacing or crowding and apparent loss of tooth structure by attrition in frontal teeth, patients with asymmetries and abnormalities in tooth size or shape as well as patients with marginal periodontitis and gingival recession.

Methodology

Preparation of dental casts

Impressions of both maxillary and mandibular dentulous arches were taken in irreversible hydrocolloid material impression (Jeltrate normal setting, Dentsply) using (D.P.I) stock impression trays. After the material was set , it was removed from the mouth, thoroughly washed under running water and poured immediately with ADA type III dental stone (Kalstone, kalabhai ltd.) using a mechanical vibrator . Bases of the impressions were formed with the use of base former, and thus dental casts were obtained. The damaged stone casts were excluded from the study.

Measurements

- All measurements were taken directly on the maxillary dental casts using a precise digital calliper with a 0.01 precision level with a range of 0-150 mm and a flexible millimetre ruler.
- All measurements were recorded in mm and were done by one person.
- Each measurement was taken three times and the average of these values was obtained.

Dental measurements

The following dental measurements were made

- Mesiodistal width of right and left central incisors
- Mesiodistal width of right and left lateral incisors
- Mesiodistal width of right and left canines

Method of recording: Mesial and distal interproximal contact points of right central incisors were marked and measurements were made in a straight line by the digital vernier calliper (figure 1).

In the same way, the mesiodistal width of left central incisor, right and left lateral incisor and right and left canine were also measured.

Sum Total mesiodistal width of six maxillary anterior teeth (SMxAT) – was obtained by adding together the mesiodistal width of the left and right central incisor, the left and right lateral incisors and the left and right canines.

The intercanine cusp tip width (ICTW) – Cusp tips of maxillary right and left canines were marked and the measurement was recorded with the help of the digital vernier caliper in a straight line (figure 2).

The circumferential arc distance between the distal surface of the canines (ARCD) - The disto-proximal contact points of the left and the right maxillary canines were marked and this distance was measured with a flexible millimetre ruler (placed over the labial side of the maxillary anterior teeth) (figure 3).

DENTAL ARCH MEASUREMENTS

Frontal maxillary arch width (FMAW) - Graphite marks were made on central fissures of left and right maxillary 1st premolars. This distance was measured on a straight line using digital vernier caliper (figure 4).

Distal maxillary arch width (DMAW) - Apices of mesial triangular fossae of the left and right maxillary 1st molar teeth on the dental casts were marked and this distance was measured on a straight line using digital vernier caliper. (figure.5)

Inter hamular width (IHW) - The most mesial demarcation point of hamular notches were identified on the dental casts and marked. This distance between the two pterygomaxillary notches was measured on a straight line using a digital caliper (figure 6).

Data Analysis

The data were analysed using the SPSS 10.0 software program for windows, means, medians, standard deviations, standard error of means were calculated. Significance of difference between means of the measurements was tested using paired t test. Ratios of the means of tooth and arch dimensions were

also calculated. The level of significance was established as alpha = 0.05 for all statistical measurements and t value >1.96 = significant.

RESULTS

In all the 70 individuals (figure 7) represents the the mean of maxillary central incisor, lateral incisor, canine. Whereas (figure 8) shows the means of (SMxAT), (ICTW), (ARCD), (FMAW), (DMAW) and (IHW).

In this study statistical difference was found out between the means of arch dimensions (FMAW, DMAW and IHW) and the tooth measurements such as (SMxAT, ICTW and ARCD) which are showed in (table 1). It was observed that there was statistically significant difference (i.e p<0.05) between frontal maxillary arch and all the parameters related to the width of six maxillary anterior teeth (SMxAT, ICTW and ARCD). Therefore these results indicated that FMAW was not a reliable indicator for selection of mesiodistal width of maxillary anterior teeth. This table also showed that there was no statistically significant difference between DMAW and SMxAT (i.e p>0.05). However statistically significant difference was found between DMAW, ICTW and ARCD (i.e p<0.01). It was also observed (see table 1) that there was no statistically significant difference between IHW and SMxAT (i.e p>0.05) with the lowest difference in the mean of 0.176 mm. However statistically significant difference was found between IHW, ICTW and ARCD (i.e p<0.01).

The ratios were calculated between the means of arch dimensions (IHW, FMAW and DMAW) and tooth measurements (SMxAT, ICTW, and ARCD) and are presented in (table 2). It was observed that the ratio between IHW and SMxAT and the ratio between DMAW and SMxAT were almost equal to 1 where as other ratios were not statistically significant.

Table-1: Showing the significance of difference in means between arch dimensions (FMAW, DMAW and IHW) and the tooth measurements (SMxAT, ICTW and ARCD)

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed) P value
Pair 1	SMxAT and FMAW	9.841	1.9049	.2276	43.241	69	<0.01 (HS)
Pair 2	ICTW and FMAW	1.265	1.2593	.1505	8.408	69	<0.01 (HS)
Pair 3	ARCD and FMAW	16.884	2.7912	.3336	50.608	69	<0.01 (HS)
Pair 4	SMxAT and DMAW	.2322	2.4462	.2923	0.794	69	.430 (p>0.05) (NS)
Pair 5	ICTW and DMAW	11.343	2.2263	.2660	42.62	69	p<0.001 (HS)
Pair 6	ARCD and DMAW	6.8065	3.3279	.3977	17.11	69	p<0.01 (HS)
Pair 7	SMxAT and IHW	.1767	.7916	.0946	1.86	69	0.066 (P>0.05) (NS)

Pair 8	ICTW and IHW	10.934	1.4798	.1768	61.81	69	p<0.001 (HS)
Pair 9	ARCD and IHW	7.2155	2.3752	.2838	25.41	69	p<0.01 (HS)

df= degree of freedom, NS = Not Significant , HS = Highly Significant, p> 0.05 = not significant , p<0.05 = significant, p<0.01 = highly significant t value > 1.96 = significant, t value < 1.96 = non –significant

Table-2: Showing ratios between the means of arch dimensions (IHW, FMAW and DMAW) and tooth measurements (SMxAT, ICTW and ARCD)

s.no	RATIOS	Minimum	Maximum	Mean	Std. Deviation
1.	FMAW/SMxAT	.71	.88	.782	.04012
2.	FMAW/ ICTW	.94	1.16	1.037	.03773
3.	FMAW/ARCD	.59	.84	.677	.04330
4.	DMAW/SMxAT	.86	1.17	1.005	.05491
5.	DMAW/ ICTW	1.13	1.54	1.334	.07110
6.	DMAW/ARCD	.72	1.08	.871	.06113
7.	IHW/SMxAT	.96	1.05	.996	.01777
8.	IHW/ ICTW	1.22	1.44	1.322	.05189
9.	IHW/ARCD	.78	1.04	.836	.04215



Fig-1: Measurement of mesiodistal width of right maxillary central incisor



Fig-2: Measurement of intercanine cusp tip width (ICTW)

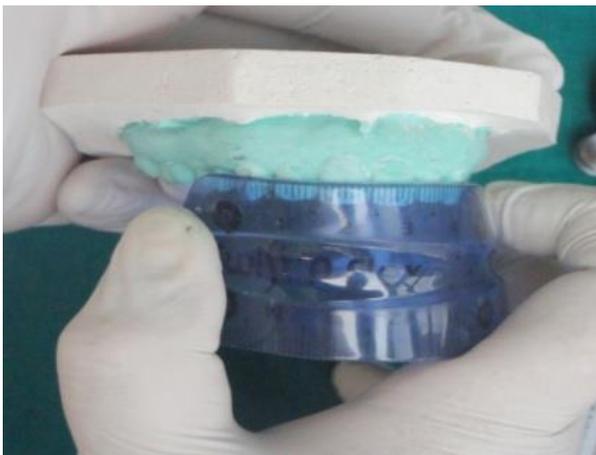


Fig-3: Measurement of circumferential arc distance between the distal surfaces of the canines (ARCD)



Fig-4: Measurement of frontal maxillary arch width (FMAW)



Fig-5: Measurement of distal maxillary arch width (DMAW)



Fig-6: Measurement of inter hamular width

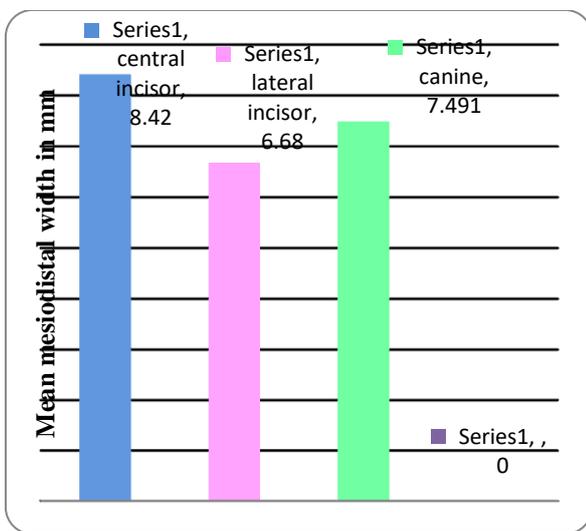


Fig-7: Showing means mesiodistal width of central incisor, lateral incisor and canine

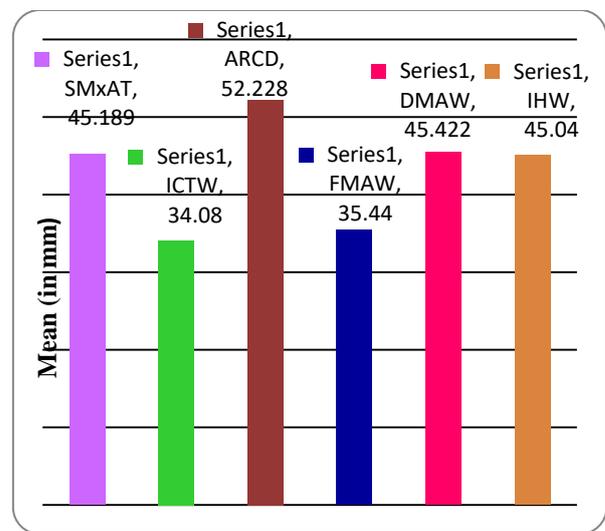


Fig-8: Showing the mean of (SMxAT), (ICTW), (ARCD), (FMAW), (DMAW) and (IHW)

DISCUSSION

Denture esthetics has been defined as the cosmetic effect produced by a dental prosthesis which attains the desirable beauty, attractiveness, character and dignity of an individual [13]. Over a period of many years, we have tried to find out simple and practical method of making dentures that look natural and pleasing. We as a prosthodontist desire, speed and accuracy with minimum failures [14]. With growing esthetic demand, the maxillary anteriors play a critical role in prosthodontic success, as these are the teeth which are most visible when viewed from the frontal aspect. The selection of maxillary anterior teeth for complete dentures has long posed a problem in clinical practice especially when no preextraction records are available, and a controversy about the best method to employ still exists.

In the present study measurement of the maximum mesiodistal width of each maxillary anterior tooth was measured from the contact points on the dental casts with the help of digital vernier caliper. Brand and Isselhard and Berkovitz reported that the

width of the maxillary central incisor was 8.5 mm, the width of the maxillary lateral incisor was 6.5 mm, and the width of the maxillary canine was 7.5 mm, which is similar to the results of the present study.

In this study, the mean of SMx AT was found to be 45.19. This value was similar to the mean value of 45.23 mm, 45.60 mm and 45.80 mm reported by Al Wazzan [3], Anitha *et al.* [15] and Shillinberg *et al.* [17] respectively. Whereas Aleem *et al.* [18] reported a mean of 43.00 mm for the Saudi population. Guldag *et al.* [12] reported a mean value of 46.02mm in Turkish population. In our study the measurement of inter canine cusp tip width (ICW) showed a mean of 34.079 mm. This mean of ICTW was similar to the mean value of 34.30 reported by Mavrouskoufis and colleagues [19] who recorded the intercanine cusp tip width with dividers to an accuracy of 0.1mm. The mean of ICTW in the present study was also similar to the mean value of 34.15 and 34.19 mm obtained by Bonakdarchian *et al.* [20] and Petricevic *et al.* [21] respectively. Gomes *et al.* [22] reported a median value of 37.44 mm, this median value of ICTW was significantly larger than the

mean value obtained in the present study. This may be due to the fact that Gomes *et al.* measured the ICTW in digital photographs rather than taking measurements on the dental casts, so they may have some errors because of the effect of the third dimension of antero-posterior length. In this study the mean of circumferential arc distance from the distal surfaces of the canines (ARCD) was found to be 52.22 mm (see figure 8). Petricevic and associates [21] also measured the ARCD from the distal surface of canines and reported a mean value of 52.05 which was similar to the mean value found in the present study. Scandrett *et al.* [10] also measured the ARCD and reported the mean of 53.61 mm. The larger value reported by Scandrett *et al.* may be attributed to the different method of measurement for ARCD, as they measured this distance with the help of dental tape and then measured this distance with the boley gauge.

The mean of FMAW was found to be 35.44 mm. This value was similar to the value of mean of 35.80 mm reported by Petricevic *et al.* [21] and the mean value of DMAW in our study was found to be 45.42 mm which was similar to the mean value reported by Petricevic and colleagues who obtained mean value of 46.01 mm for DMAW in Croatian females in their study. This is in accordance with the present study as sample size of this study consisted predominantly of females. The mean value for IHW was found to be 45.01 mm (see figure 8). Guldag *et al.* [16] reported a mean value of 42.38 mm for IHW in Turkish population. Petricevic [21] reported a mean value of 47.10 mm for IHW in Croatian population. The difference in the mean of IHW in the present study and other studies may be due to different method of measurement and also might be due to racial, genetic, environmental and cultural factors.

In the present study no statistically significant difference was found between the IHW and the sum of the widths of maxillary anterior teeth (SMxAT) and DMAW (i.e $p > 0.05$ and $t < 1.96$ see Table 1). The ratio between IHW and SMxAT was found to be 0.996 which was almost equal to 1, this was found to be statistically significant ($p < 0.05$) see table 2. Also the ratio obtained between the means of DMAW and SMxAT was found to be 1.005 which was nearly equal to 1 (table 2). Therefore both IHW and DMAW might be considered as a useful tool for determination of mesiodistal width of permanent maxillary anterior teeth. However it has been emphasized by Kovacic *et al.* [23] that the alveolar ridge of distal maxillary arch width is subjected to severe resorption after distal tooth extraction while the interhamular width remains within the same dimension. Also after the loss of maxillary 1st molar, DMAW is lost, as it is determined by the tooth position and it is not possible to reconstruct it because of individual rate of alveolar bone resorption. However, the hamular notches have been considered to be reliable landmark because firstly they are not submitted to resorptive changes after teeth extraction. Secondly, they

do not appear to change with factors such as weight changes and aging. Thirdly, these can be easily identified on the dental casts. Therefore, on the basis of above facts, the measurements of interhamular width (IHW) could be a practical method for clinical application in artificial teeth selection IHW is not determined by teeth position but by anatomical structures. Consequently, Interhamular width (IHW) is a suitable reference for maxillary anterior teeth width selection.

These finding were in accordance with the previous study done by Petricevic *et al.* [24] and Agnihotri G [7] who also found statistically insignificant difference between IHW and SMxAT. Therefore, IHW can be used reliably as a guide for the selection of Sum total mesiodistal width of maxillary anterior teeth. Guldag and colleagues [12] reported a mean difference of 3.82 mm between IHW and SMxAT and a standardized coefficient of 28% as opposed to at least 70% to 80% for practical importance in Turkish population. Therefore, they recommended that IHW could not be used reliably for selection of artificial maxillary anterior tooth in edentulous patients. The large difference in mean between IHW and SMxAT of 3.8 mm reported by Guldag *et al.* might be explained on the basis of genetic and racial factors and the differences in the procedure of measurement, as the authors did not described the method of measurement in detail.

The customs, traditions food habits and environmental conditions of north India are distinct from the rest of the country. As such the present study defines the morphometric criterion of arch and tooth dimensions for north Indian population and in the subjects within a narrow age range (18 to 30 years). It is possible that ethnic and gender based differences in IHW may exist. Therefore further research on whether there is any relationship between maxillary anterior tooth size and interptery-gomaxillary notch distance in other racial populations with greater sample size collected more systematically is necessary to validate the outcomes of the present investigation.

CONCLUSIONS

Various guidelines have been suggested for determining the size of the maxillary anterior teeth. However, no single universally accepted method for selection of maxillary anterior teeth has yet been established despite the advancements in material science and techniques. Selection of anterior tooth size may be more appropriate using multiple facial measurements to achieve ideal esthetic outcome. A final decision about tooth selection also should be made according to patient expectations during the trial insertion stage [25].

Within the limitations of the present study, we can conclude that the interhamular width (IHW) and

distal maxillary arch width (DMAW) are almost equal to the sum total mesiodistal dimension of maxillary anterior teeth (SMxAT). But after extraction of all teeth, distal maxillary arch width is lost which is not possible to reconstruct because of different rate of alveolar bone resorption. On the other hand, IHW remains of the same dimension during lifetime, because it is not determined by teeth position but determined by anatomical structures. Therefore, it can be concluded that measurements of IHW could be a practical method for clinical application, for determination of sum total mesiodistal width of maxillary anterior teeth tooth (SMxAT). Therefore, the information gained on the basis of this study will be helpful in the selection of artificial maxillary anterior teeth and may help to guide the clinicians to impart a dental appearance that is harmonious with overall facial esthetics in completely edentulous patients.

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