

RESEARCH ARTICLE

CORRELATION OF THE DISTANCE BETWEEN PTERYGOMAXILLARY NOTCHES AND THE COMBINED WIDTH OF MAXILLARY ANTERIOR TEETH IN DENTATE SUBJECTS - AN OBSERVATIONAL ANALYTICAL STUDY

Shari S.R, Harshakumar K., Kavitha Janardanan, Litty Francis and Sariga Kanagaraj

Manuscript Info Abstract Manuscript History Purpose: The objective of this study was to find the correlation of the distance between pterygomaxillary notches and the combined width of maxillary anterior teeth.Material &Methods:One hundred and twenty-six maxillary dentulous impressions were made (18-50 years old) using metallic stock tray and irreversible hydrocolloid impression material, then poured in dental stone. The distance between Pterygomaxillary notches and the measurements was statistically analysed using Pearson's correlation co-efficient. Results: The mean distance between pterygomaxillary notches was 39.5 ± 3.7mm and the mean of combined width of six maxillary anterior teeth was 45.5 ± 2.A moderately significant correlation was found for the distance between pterygomaxillary notches and the combined width of maxillary anterior teeth and the distance between the combined width of maxillary anterior teeth and the distance between the pterygomaxillary notches. Conclusions: The relation between the combined width of maxillary anterior teeth and distance between pterygomaxillary notches was significant (p-0.01). The distance between pterygomaxillary notches is a reliable method for the selection of maxillary	••••••	
 Manuscript History Received: 31 May 2022 Final Accepted: 30 June 2022 Published: July 2022 Published: July 2022	Manuscript Info	Abstract
involving renabilitation of maximally anterior teeth.	Manuscript History Received: 31 May 2022 Final Accepted: 30 June 2022 Published: July 2022	Purpose: The objective of this study was to find the correlation of the distance between pterygomaxillary notches and the combined width of maxillary anterior teeth.Material &Methods:One hundred and twentysix maxillary dentulous impressions were made (18-50 years old) using metallic stock tray and irreversible hydrocolloid impression material, then poured in dental stone. The distance between Pterygomaxillary notches and the mesiodistal width of six maxillary anterior teeth were measured by digital vernier calliper on a dental stone cast. The mean of the measurements was statistically analysed using Pearson's correlation co-efficient. Results: The mean distance between pterygomaxillary notches was 39.5 ± 3.7 mm and the mean of combined width of six maxillary anterior teeth was 45.5 ± 2.4 moderately significant correlation was found for the distance between pterygomaxillary notches and the combined width of maxillary anterior teeth (p<0.01, r=0.335).Only 11.2 percent of the samples showed a correlation between the pterygomaxillary notches was significant (p<0.01). The distance between the pterygomaxillary notches was significant (p<0.01). The distance between the pterygomaxillary notches and the factors. It was concluded that for every 1mm increase in the distance between the pterygomaxillary notches in the distance between pterygomaxillary notches in the distance between pterygomaxillary notches in the distance between pterygomaxillary notches are in the dimension for the combined width of maxillary anterior teeth. Distance between pterygomaxillary notches is a reliable method for the selection of maxillary anterior teeth. Endet the difference of the selection of maxillary anterior teeth. 2. This correlation can be applied to any restorative procedures involving rehabilitation of maxillary anterior teeth.

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Corresponding Author:- Shari S.R

Introduction:-

A Person's social position is influenced to some extend by his or her personality. Physical attractiveness, particularly of the face, is strongly linked to personality. For a good-looking face, a natural and balanced smile is vital.¹ Dental aesthetics are thought to be a significant component of a person's appealing smile. Many patients regard prosthetic treatment as the ideal solution for excellent aesthetics because of these factors.²However, to get a satisfying treatment outcome, optimum facial aesthetics are required.³

The selection of denture teeth is critical to achieve the finest outcomes. Size,contours, Incisal edges,occlusal plane and midline must all be in harmony to provide a pleasant face, especially when the patient smiles. The purpose of prosthodontic treatment in the maxillary anterior segment of the mouth is to provide a beautifully balanced smile by ensuring that teeth, gingiva, lips and face interact appropriately.³

The maxillary central incisors are the fundamental part of anterior dental esthetics and play a vital role in the fabrication of complete dentures.⁴ If the teeth selection does not meet the patient's cosmetic standards, the patient may be extremely disappointed.⁵Therefore, selection of maxillary anterior teeth is challenging and crucial aspect of prosthodontic rehabilitation.⁵

Many studies have found a relationship between the size of the maxillary anterior teeth and numerous facial landmarks.^{6–9} Levin proposed the 'Golden proportion' to describe the relationship between the widths of successive anterior teeth when viewed from the frontal aspect.¹⁰ To determine the mesiodistal width of anterior teeth, Snow proposed the 'Golden percentage'.¹¹ Ward developed the notion of Recurring Esthetic Dental Proportion more recently.¹² It is a method for finding the appropriate size and position of the anterior teeth.When moving distally from the midline, he claims, the ratio of the width of successive teeth remains constant.

Extraoral anatomic landmarks such as bi-zygomatic width, inter-canthal width, inter-alar width and intercommissural width have been recommended as a guide for determining the size of anterior teeth.^{13,14}Soft tissue measures are used in all these biometric approaches for prosthetic teeth selection. However, because there is no static spatial relationship between soft tissue structures, the accuracy of these measurements is often questioned. Furthermore, the width of soft structures might vary depending on the person's weight, age, and built.As a result, a solid relationship between the size of anterior teeth can only be established when landmarks independent of such parameters are used. Therefore, adopting a landmark that is less impacted by dynamic changes overtime provides a more consistent strategy for selection of anterior teeth.⁴

Many intraoral anatomical landmarks have been chosen as guides to pick the width of six maxillary anterior teeth that are regarded to be independent of dynamic alterations. These include the incisive papilla, hamular notches and mesio-palatal cusp of second molar.¹⁵ When the hamular notch and incisive papilla were employed to select maxillary anterior teeth, Bing et al and Shivaji et al found significant results. The incisive papilla is commonly utilised as a guidance for positioning the labial surface of maxillary central incisors.^{6,16,17,18} However, because of its resorption with age, the form of incisive papilla changes from person to person, and some studies have shown that it cannot be used as a reliable landmark. Following the extraction of central incisor teeth, the alveolar bone, interdental papilla, and palatal mucosa remodel, causing changes in the form of the incisive papilla during the transition from a dentulous to edentulous state.¹⁹ Baker et al found a relationship between the inter-pterygomaxillary notch distance was also employed by Johnson and Stratton as a guide for prosthetic teeth selection.²¹

The pterygomaxillary notch is a palpable notch formed by the junction of the maxilla and pterygoid hamulus of sphenoid and it is a stable landmark which does not alter with weight, age and tooth extraction.²²Throughout life, the distance between the right and left hamular notches remains consistent.²³Pterygomaxillary notches, which can be seen on dental cast, can be used an an alternative anatomical landmark for selection of anterior teeth.

Materials & Methods:-

The present Observational-Analytical study was conducted in the department of prosthodontics of our institute. The patient who fulfilled the following criteria were included in the study. On applying the formula for sample size calculation, with the values obtained from the reference article a sample of 126 has been considered.⁴

 $\mathbf{n} = [(Z_{\alpha}+Z_{\beta}\sqrt{1-r^2})^2 \div r^2 + 2], \mathbf{Z}_{\alpha} = \text{Value of standard normal variable at alpha level ;1.96 (two tailed), } \mathbf{Z}_{\beta} = \text{Value of standard normal variable at beta level;0.84 (one tailed), } \mathbf{r} = \text{Pearson's correlation co-efficient, } \mathbf{n} = \text{Sample size.}$

Inclusion criteria include study subjects of 18 to 50 years old, normal class I occlusion, dentulous patients and presence of maxillary teeth, at least up to second molar.

Exclusion criteria include subjects with congenitally missing anterior teeth, subjects with trismus or limited mouth opening, subjects with orthodontic intervention, tooth size or shape deformity, cases with anterior tooth restorations and crowding.

Procedure:-

Maxillary impressions were made on dentate subjects using irreversible hydrocolloid impression material and stock tray. Intraorally a 'T' burnisher was used to locate the pterygomaxillary notch precisely and by using indelible pencil pterygomaxillary notch was marked, so it could be transferred into the impression. To correctly register the pterygomaxillary notch and to reduce the soft tissue distortion, the impressions were made under minimal pressure. The stone casts were poured using ADA Type III dental stone (Shruthi products). Damaged stone cast were excluded from study.

The pterygomaxillary notches were identified on each stone cast and marked with the graphite. The distance between two pterygomaxillary notches on both the sides were measured on a straight-line using digital vernier calliper (Fig.1). In addition, the mean of these values was taken. The individual anterior tooth width measurements were added to give the combined width of the six maxillary anterior teeth (Fig.2). The mean of maxillary anterior teeth width measurements was also taken. All the measurements were carried out in millimetres (mm). Mean of these measurements were compared to find the correlation between these parameters.

Data management and analysis

In the present study correlation of the distance between pterygomaxillary notches and the combined width of maxillary anterior were assessed by means of Pearson's correlation co-efficient (r), because both the measurements are in millimetres. The regression analysis was used for finding out the prediction of one measurement from the other (Anterior teeth width using inter-pterygomaxillary notch distance). Significance was assessed by using a 'p' value less than 0.05 (5%). Data analysis were done with a computer software, STATISTICAL PACKAGE FOR SOCIAL SCIENCES (SPSS) VERSION 20.

Results:-

Correlation between combined width of maxillary anterior teeth (Table.1) and distance between pterygomaxillary notches (Table.2) were assessed using Pearson'sCorrelation Co-efficient ('r'). The 'r' value can range from -1 to +1. The value near to +1 and -1 shows a strong correlation. Here 'r' value obtained was 0.335 which shows a moderate positive correlation between the values (Fig.3). The correlation between the values was significant (p<0.01). The correlation between the width of maxillary anterior teeth and distance between pterygomaxillary notches based on subsamples age and sex (Table 3,4). The study was significant between the age group of 21-25 (p=0.04) and 26-30 (p=0.01) and not significant for the age group of 31-36 (p=0.1). Correlation between these two variables was significant for both males and females (p<0.05). Theinfluence of distance between the Pterygomaxillary notches on Combined width of maxillary anterior teeth were analysed. Combined width of maxillary anterior teeth = 38.21 + distance between the pterygomaxillary notches x 0.186, Where 'B' denotes Regression co-efficient, R² is the co-efficient of determination. The R² value helps to predict the dependant variable (Table.5).

Discussion:-

Artificial teeth selection is an important determining factor for aesthetics in removable prosthodontics. It is achieved by incorporating proper shape and exact dimension of teeth on artificial dentures.²³ Numerous methods have been proposed for selection of appropriate artificial tooth size. However, none of these methods can solely be used for tooth selection reliably as most of these studies relied upon extraoral landmarks for determination of anterior teeth selection.⁴Many authors have demonstrated inconsistencies in relating extraoral measurements to artificial teeth selection. Moreover, the width of soft structures may change based on weight, age and built of the person.⁴Many intraoral anatomical landmarks have been selected which are considered to be independent of dynamic changes and

used as guides to select the width of six maxillary anterior teeth. Data correlating the dimensions of hard palate with those of the maxillary anteriors is scarce in literature.

The present study was conducted to assess the dimensional relationship between maxillary anterior teeth and interpterygomaxillary notch distance. Pterygomaxillary notch is considered as a reliable anatomical landmark since, they are independent to resorptive changes overtime. As well the position of the pterygomaxillary notches do not appear to change with factors such as weight changes, aging and extraction of teeth.^{22,23} Therefore, interpterygomaxillary notch distance has been chosen as a reference in order to calculate the width of maxillary anterior teeth. The pterygomaxillary notch is a palpable notch formed by the junction of maxilla and pterygoid hamulus of the sphenoid bone.

The present study observed 126 patients belonging to the age group of 21-36 years (mean 28.1 ± 3.4). Out of which 23.8% belongs to 21-25 age group,53.2% of the sample comes in 26-30 age group,23% of sample included in 31-36 age group. The selected patients included 50.8% female and 49.2% male. The combined width of maxillary anterior teeth was found to be 45.5mm which is in accordance with the previous studies.^{4,9,18}Likewise, the mean width of distance between the pterygomaxillary notches is 39.5 ± 3.7 which is closer to the values obtained in other studies conducted in different populations.^{4,18,20,24}. In this study a positive correlation was obtained between combined width of maxillary anterior teeth and width of inter pterygomaxillary notches and thus, null hypothesis was rejected so that the study was statistically significant (P<0.01). The correlation was significant for the age groups of 21-25 & 26-30 years old and not significant for 31-36 years old. A significant correlation was obtained for both genders and more for males. The mean difference between combined width of six maxillary anterior teethand the distance between the pterygomaxillary notches is 6 mm. Whereas **Guldag et al**, obtained a mean difference of 3.82mm. The discrepancy between the results can be attributed due to racial variations.⁴

The prediction of combined width of maxillary anterior teeth using distance between pterygomaxillary notch is carried out using linear regression analysis. The regression analysis was carried out to check whether any formulae or proportion can be derived to predict the combined mesiodistal dimension of anterior teeth from the inter pterygomaxillary notch distance. From the results obtained it can be concluded that for every 1mm increase in the distance between the pterygomaxillary notches, there will be a 0.18mm increase in the dimension for the combined width of maxillary anterior teeth (Table.5).

According to this study, inter-pterygomaxillary notch distance is found as a valuable factor for selection and arrangement of anterior teeth. However, the Correlation co-efficient(r) was comparatively small (0.335,34%), as opposed to at least 70% to 80% for practical importance. Therefore, the standard correlation co-efficient was too low to predict accurate teeth size using the pterygomaxillary notch distance alone (Graph.1). **Guldag et al**obtained acorrelation co-efficient or 'r value' of 0.28 (28%) whereas **Shrestha et al** reported a value of 0.217(21%).^{4,18} Due to their lower 'r' values, theyconcluded that distance between pterygomaxillary notches solely cannot determine the total width of maxillary anterior teeth. However, it is interesting to note that the technique such as inter alar and inter canthal width currently being used have shown a much less correlation.^{14,25,26} For a better prediction **Scandrett**suggested use of two or more soft tissue landmark than any of them individually.²⁷In the present study correlation was found only in 11.2% of the samples and the remaining 88.8% shows variation due to other factors (Table.5). This method cannot be considered as an exclusive method for the determination of anterior teeth size. However, it can be used as adjunct method for the selection of size of maxillary anterior teeth. Further such studies need to be carried out among different racial groups.

It is further seen that the reliability of the method used in the study is superior to that employs soft tissue landmarks. In the present study, young participants were selected in order to avoid morphological alterations often associated with aging. All measurements were collected by the same operator from all the subjects in order to minimise error in the measurements. The measurements were made from the dental casts rather than measurements made directly from the patient to avoid the resiliency. **Hunter and Priest** also reported that obtaining measurements from cast was more advantageous than taking directly from the mouth.²⁸ The accuracy of dental cast made from irreversible hydrocolloid impression as a representation of actual teeth, dental arches and hard palate dimension was investigated by different authors. The results of their study concluded that irreversible hydrocolloid impressions produced the most accurate dental casts when poured immediately.^{29–31}**Mack** showed that setting expansion of dental stone is found to be as small as 2.2% which may not influence the result.³² All the measurements were made from the cast using digital Vernier Calliper. According to **Zilberman et al** in 2003, it was found that measurements of anatomical

landmarks on a dental cast can be accurately reproduced with a digital Vernier Calliper.³³ The study concluded that there is a correlation between combined width of maxillary anterior teeth and inter-pterygomaxillary notch distance.

Limitations of the study

- 1. This study does not verify the correlation between width of inter pterygomaxillary notches and total width of maxillary anterior teeth in the denture. Further studies thatfocus on this correlation among the edentulous age groups need to be carried out to arrive at a definitive conclusion.
- 2. Parameters such as proximal wear of teeth with aging, gender and racial variations in tooth size, difference in size of dentition on the left and right side and the geographical homogenous sample are the limitations of our study.

Conclusion:-

- 1. The relation between the combined width of maxillary anterior teeth and distance between the pterygomaxillary notches was significant (p<0.01).
- 2. The distance between Pterygomaxillary notches can influence the size of maxillary anterior teeth along with other factors.
- 3. The correlation in combined width of maxillary anterior teeth using the distance between the Pterygomaxillary notches could be observed in 11.2% of samples only.
- 4. The regression analysis implied that for every 1mm increase in the distance between the Pterygomaxillary notches, there will be a 0.18mm increase in the dimension for the combined width of maxillary anterior teeth.

Tables

Table 1:- Descriptive statistics regarding combined width of maxillary anterior teeth.

Mean	45.5
SD	2.0
Q1	44.2
Median	45.5
Q3	46.8
Minimum	38.8
Maximum	52.5

Q1- Upper quartile, Q3- Lower quartile, SD- Standard deviation

Table 2:- Descriptive statistics regarding distance between the pterygomaxillary notches

Mean	39.5
SD	3.7
Q1	36.8
Median	38.8
Q3	42.1
Minimum	33.8
Maximum	50.3

Q1- Upper quartile, Q3- Lower quartile, SD- Standard deviation

Table 3:- Correlation between Combined width of maxillary anterior teeth and distance between the pterygomaxillary notches based on age.

Age	R	р
21 - 25	0.375*	0.041
26 - 30	0.312*	0.010
31 – 36	0.286	0.133

* - Significant at 0.05 level

 Table 4:- Correlation between Combined width of maxillary anterior teeth and distance between the pterygomaxillary notches based on sex.

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Male	0.389**	0.002
Female	0.264*	0.035

** - Significant at 0.01 level, * - Significant at 0.05 level, r-correlation coefficient, p- probability value

 Table 5:- Influence of distance between the pterygomaxillary notches on Combined width of maxillary anterior teeth.

Constant	В	t	р	R ²
38.21	0.186	2.55	P<0.01	0.112

B-Regression co-efficient, R^2 -Co-efficient of determination

Figure Legends:

Figure 1:- Distance between pterygomaxillary notches was measured using digital vernier caliper.



Figure 2:- Width of maxillary anterior teeth was measured using digital vernier calliper.







Financial support and sponsorship

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

There are no conflicts of interest.

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