Original Research Article

Comparative analysis of dental arch width and inter-hamular notch distance with maxillary anterior teeth width among young dentulous Gujarati individuals

Rutu Paresh Shah [1]*, **Shruti Parthiv Mehta**[1], **Ankita Bansal**[2]

[1]*Dept. of Prosthodontics and Crown & Bridge, College of Dental Sciences and Research Centre, Gujarat University, Ahmedabad, Gujarat, India*
[2]*Dept. of Public Health Dentistry, College of Dental Sciences and Research Centre, Gujarat University, Ahmedabad, Gujarat, India*

A B S T R A C T

Background: Appropriate selection of shape and form of artificial teeth is of vital importance in order to make the prosthesis look natural. The intraoral and extraoral landmarks can serve as helpful guides for the same.

Aim: The current study was undertaken with the aim of comparing the interhamular-notch distance and the arch width (via inter-molar distance) with the dimensions of anterior teeth to determine if a correlation exits between them.

Materials and Methods: 50 participants (39 females and 11 males) fulfilling the inclusion and exclusion criteria were selected. Full arch maxillary impressions were made in irreversible hydrocolloid material and type III dental stone was used to obtain the casts. The distance between bilateral hamular notches (IHND) and between the mesiopalatal cusp tips of both first molarsleft (IMD) were recorded. These measures were then compared with the straight distance between cusp tips of left and right maxillary canine (CCS) and total combined width of six anterior teeth (CCC).

Result: There existed a statistically significant correlation between IHND and CCC(p = 0.01) as well as IHND and CCS(p= 0.02). However, the IMD had statistically significant correlation with CCC only (p=0.02).

Conclusion: The inter-hamular notch distance can be used as a reliable predictor for straight inter-canine distance and also the combined six maxillary anterior teeth width whereas the palatal width via inter-molar distance can be used for the determining the combined anterior teeth width only.

1. Introduction

Prosthodontics is a continuously evolving field of dentistry that replaces teeth or tooth structure via multiple types of prosthesis. The stakes are especially high when the prosthesis involves the aesthetic zone or more specifically the anterior maxillary region.

The maxillary anterior teeth are not just responsible for the aesthetics but also the phonetics, the lip support and a harmonious incisal guidance. For patients who are completely edentulous, setting the teeth as close to their original position can fulfill the abovementioned factors. However, it may be a challenging task in absence of pre-extraction records.[1] Over the years, many moulds, shade guides and templates have been proposed for selection of complete denture teeth.[2,3] Also a number of anthropometric studies have been carried out in different population groups using intra-oral or extraoral landmarks for selecting size and shape of teeth. But in absence of a fundamental

* *Corresponding author.*
E-mail address: shahrutu.rs@gmail.com (R. P. Shah).

approach which may be applied universally irrespective of the ethnicity or gender, selection of appropriate teeth for fixed or removable prosthesis relies solely on the perception and judgement of the clinician and laboratory technician.

2. Aim

The current study was conducted involving 50 fully dentulous Gujarati individuals to analyse the correlation between width of dental arch (via the inter-molar distance) and inter-hamular notch distance with the combined width of the maxillary anterior teeth and straight distance between canine cusp tips.

3. Materials and Methods

The study was conducted in the Dept. of Prosthodontics and Crown & Bridge, College of Dental Sciences and Research Centre, Bopal. It was carried out in accordance with the protocols reviewed and approved by the Institutional Ethical Board. The study also adhered to the Declaration of Helsinki.

3.1. Study design

50 participants (39 females and 11 males) between the ages of 18-35 participated in the study and an informed consent was obtained from each of them. The participants met the inclusion criteria of presence of all maxillary teeth from central incisor to second molar. Participants with dental malposition, diastema, attrition or history of orthodontic treatment were excluded from the study.

3.2. Procedure

A full arch maxillary impression was made in each of the participants in a metal tray with irreversible hydrocolloid impression material (Tropicalgin, Zhermack). Then, the impressions were poured in Type III dental stone (Goldstone, Asian chemicals) and casts were obtained.

The following points were marked on the cast with a fine tip graphite marker:

1. Both cusp tips of Left and right maxillary canine.
2. The point of Contact of left and right maxillary canines with their respective first premolar.
3. Left and right maxillary first molar mesiopalatal cusp tips.
4. Center of left and right hamular notches.

With help of an electronic digital caliper (Zhart Company) with an accuracy of ±0.02 mm, the following measurements were made:

1. Straight distance between the left and right maxillary canine cusp tips (CCS) (Figure 1)

2. Linear distance between the midpoint of left and right hamular notches (IHND)(Figure 2)
3. Linear distance between left and mesiopalatal cusp tips of maxillary first molars (IMD)(Figure 3)
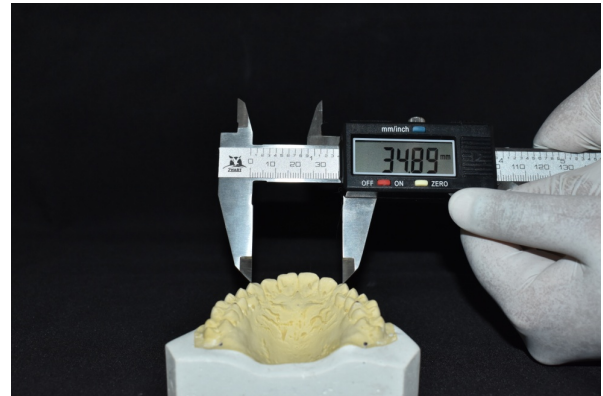
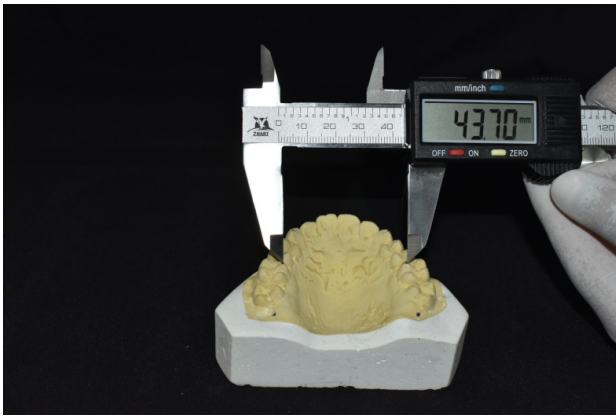**Figure 1:** Measurement of straight distance between left and right canine cusp tips (CCS)

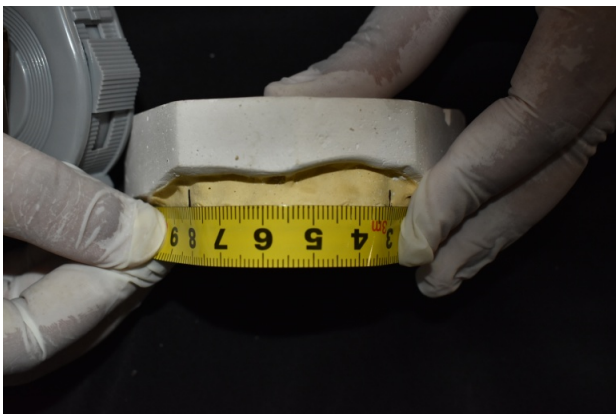**Figure 2:** Measurement of distance between left and right hamular notch (IHND)

A flexible ruler was used to measure the curved distance between the distal contact points of left and right maxillary canines with first premolar (CCC). (Figure 4)

3.3. Statistical analysis

SPSS software (version 22.0; IBM Corp.; U.S.) was used for the statistical analysis. The intermolar and the inter-hamular notch distances were compared with the linear distances between canine cusp tips and the curved distance of 6 maxillary anterior teeth each. Karl Pearson's correlation coefficient was derived for each comparison and p value was obtained to check for significance of correlation.

Figure 3: Measurement of distance between mesiopalatal cusps of left and right first molar (IMD)

Figure 4: Measurement of curved mesiodistal width of six anterior teeth (CCC)

r = Pearson's correlation coefficient; R² = Coefficient of determination

Figure 5: A scatter plot and the corresponding regression line and regression equation for the correlation between the dependent CCS and the independent IHND
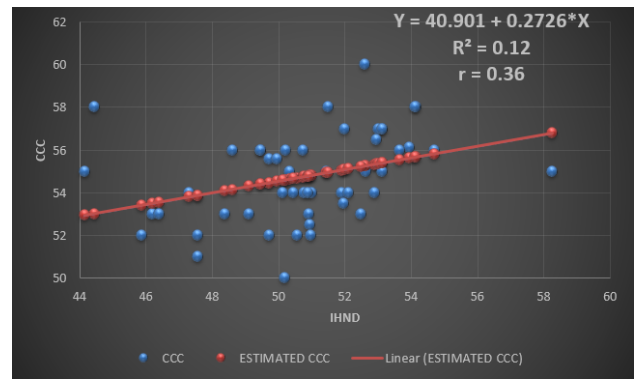
r = Pearson's correlation coefficient, R² = Coefficient of determination

Figure 6: A scatter plot and the corresponding regression line and regression equation for the correlation between the dependent CCC and the independent IHND

r = Pearson's correlation coefficient, R² = Coefficient of determination

Figure 7: A scatter plot and the corresponding regression line and regression equation for the correlation between the dependent CCC and the independent IMD

4. Results

The study sample comprised of 78% females and 22% males.

The descriptive statistics namely mean, range and standard deviation of each of the measured parameters are listed in Table 1.

Comparison via correlation analysis was done between the different parameters to derive the Karl pearson correlation coefficient.
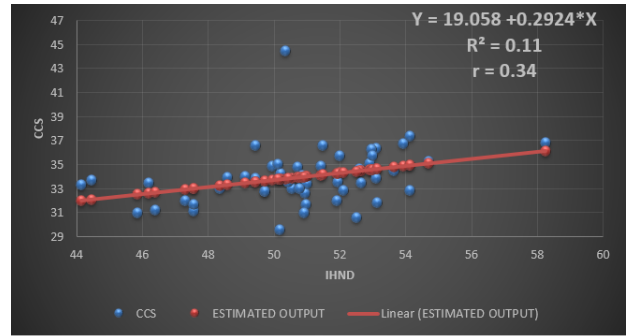
Correlation coefficient was obtained with the formula:

$r = n\Sigma xy - \Sigma x * \Sigma y / \sqrt{n\Sigma x2 – (\Sigma x)2} * \sqrt{n\Sigma y2 – (\Sigma y)2}$

where x = actual value, y = predicted value and n = total number of subjects

Interhamular notch distance and intercanine cusp tip distance as well as combined maxillary anterior width is shown in Table 2.

Correlation analysis done between Intermolar distance and intercanine cusp tip distance as well as combined maxillary anterior width is shown in Table 3.
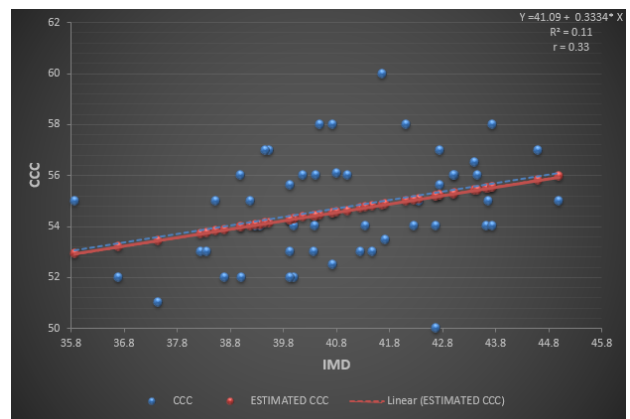
Table 1: Descriptive statistics for the measured parameters

(in mm)	Interhamular notch distance (IHND)	IntermolarDistance (IMD)	Intercanine cusp tip distance (CCS)	Combined maxillary anterior width (CCC)
Maximum	58.25	44.6	44.43	60
Minimum	44.14	35.87	29.51	51
Mean	50.75	40.92	33.90	54.74
Standard Deviation	2.72	2.06	2.37	2.08

Table 2: Correlation of Interhamular notch distance (IHND) with intercanine cusp tip distance (CCS) and combined maxillary anterior width (CCC)

Correlation parameters	Correlation coefficient (r)	Coefficient of determination (R^2)	P value
IHND –CCS	0.34	0.11	0.02*
IHND-CCC	0.35	0.12	0.01*

*Statistically significant

Table 3: Correlation of Intermolar distance (IMD) with intercanine cusp tip distance (CCS) and combined maxillary anterior width (CCC)

Correlation parameters	Correlation coefficient (r)	Coefficient of determination (R2)	P value
IMD – CCS	0.24	0.05	0.09
IMD-CCC	0.33	0.11	0.02*

*Statistically significant

Hence, it was observed that a statistically significant and positive correlation existed between the distance between the 2 hamular notches (IHND) and inter canine cusp tip distance (CCS) and also with combined mesiodistal width of the anterior teeth (CCC). In addition, a statistically significant positive correlation was obtained between the inter molar distance (IMD) and combined anterior teeth width (CCC).

Further statistical analysis was done by carrying out regression analysis between the above mentioned parameters to derive the regression formula between the independent (IHND and IMD) and the dependent (CCS and CCC) variables. The results are described in Figures 5, 6 and 7.

Hence, the distance between left and right hamular notches (IHND) and dental arch width measured via the inter-molar distance (IMD) can be used to accurately determine the combined mesiodistal width of the six maxillary anterior teeth (CCC) by the regression equations:

CCC = 40.901 + 0.2726*IHND and CCC =41.09 + 0.3334* IMD

On the other hand only the distance between left and right hamular notches (IHND) can predict the straight distance between the left and right canine cusp tips (CCS) by the regression equation:

CCS = 19.058 +0.2924*IHND

5. Discussion

In dentistry, the difference between the natural and the artificial is decreasing rapidly with advancements in techniques and materials.

In the absence of pre extraction records, a dentist has to rely on the clinical judgement and the patient's preferences in teeth selection. Non judiciously chosen anterior teeth, especially maxillary may lead to patient dissatisfaction and esthetic compromise. The color of artificial teeth can be reliably selected via a patient's complexion and in combination with clinician's judgement and patient's preference. Also the patients's photographs taken before extraction can aid in the shade selection of teeth. Hovever, the selection of size of teeth is not as easy in cases where there are no pre-extraction records.

A literature review on the current subject reveals that a number of methods have been proposed over the years to select appropriate size and form of maxillary anterior teeth. As early as in 1815, Madame Schimmelpeinik proposed the geometric classification that categorized the face form and profile for use of artists which was also utilized in dentistry for teeth selection.[4] Later, the "Typal Form Concept" was projected by Hall which was essentially a classification based on the various parameters of the anterior tooth namely, the outline form, labial surface and the width of the necks.[5] Another measure suggested was the Berry Biometric Ratio Method which said that a1:16 biometric ratio can be used to describe the relationship of the width of the maxillary central incisor to the bizygomatic width.[6] Kern conducted the 'Skull Study Project' in 1967 that compared cranial parameters to the tooth measurements.[7] Many such previous studies indicate that while some anatomical landmarks have a correlation with the mesiodistal width of all 6 maxillary anterior teeth, some others are more closely related to the mesiodistal width of maxillary central incisors. Extraoral parameters like the innercanthal

distance,[8–10] interalar width,[9,10] interpupillary distance,[11] intercommissural width,[11,12] and palatal width[13] along with incisive papilla[1,14,15] which is an intraoral landmark have been proposed to establish width and position of the maxillary anterior teeth.

The hamular notch or the pterygomaxillary notch is one such landmark. Previously carried out studies have concluded that a correlation exists between the inter-hamular notch distance and the dimensions of the six maxillary anterior teeth[16,17] It is a stable landmark and has the advantage of being clearly located intraorally as well as on the dental cast.

The present study was carried out with the purpose of determining if the inter-hamular notch distance and the mesiodistal width of the maxillary anterior teeth along with the linear distance between the cusp tips of the two maxillary canines were correlated in the considered Gujarati participants.

It was noted that within the limitations of the study, there was a statistically significant correlation of the interhamular notch distance with both the mesiodistal width of the six maxillary anterior teeth (p value=0.02) as well as with the straight distance between the cusp tips of the two maxillary canines (p value =0.01). This is in accordance with study conducted by Guldag et al[16] in the Turkish population and Shrestha et al[18] in the Nepalese population.

In cases where just the maxillary anteriors are missing or are to be rehabilitated for the purpose of esthetics (proclined, spaced or crowded anteriors), choosing the teeth size which is in harmony with rest of the dentition is important. Therefore, the arch width was taken up as another parameter which was measured via the intermolar distance (IMD) measured between the mesiopalatal cusp tips of left and right first maxillary molar. This parameter was also compared with the mesiodistal width of the maxillary anterior teeth as well as with the straight distance between the cusp tips of the two maxillary canines.

The results of the current study concluded that although the inter-molar distance had a statistically significant correlation with the mesiodistal width of the six maxillary anterior teeth (p value=0.02), there wasn't a significant correlation found with the linear distance between maxillary cusp tips. This observation is similar to the results found in a study conducted by Ellakwa[11] et al that concluded that the average dental arch width along with arch length and inter alar distance could be used to accurately determine the maxillary anterior teeth width.

5.1. Significance of study

The limitations of the current study were relatively small sample size and unequal number of male and female participants.

Hence there is a scope of further studies which may take into consideration variations based on gender, age and even arch forms.

6. Conclusion

Within the constraints of the study, it can be concluded that for the Gujarati population taken into consideration:

The inter-hamular notch distance (IHND) may serve as an accurate predictor for determining the combined mesiodistal width of maxillary anterior teeth (CCC) and also the straight distance between the maxillary canine cusp tips(CCS) by using the following regression equations:

1. CCS = 19.058 +0.2924*IHND
2. CCC = 40.901 + 0.2726*IHND

However, the dental arch width assessed by measuring the intermolar distance(IMD) possessed a statistically significant correlation with only the combined mesiodistal width of six maxillary anterior teeth(CCC) and can be calculated using the following regression equation:

CCC =41.09 + 0.3334* IMD

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Avhad R, Tembhurne J, Sar R. Evaluation of the relation of maxillary canine and edge of central incisor to incisive papilla in Indian population with respect to arch form. *J Indian Prosthodont Soc*. 2014;14(3):228–32.
2. Varjão FM, Nogueira SS. Correlating the curve distance between the distal of the canines to the combined width of the six anterior teeth when selecting denture teeth for different ethnic groups. *J Prosthet Dent*. 2012;107(6):400–4.
3. Grave AM. The frequency of various molds in a sample of natural and artificial dentitions. *J Prosthet Dent*. 1987;57(2):194–7.
4. Kumar MV, Ahila SC, Devi SS. The Science of Anterior Teeth Selection for a Completely Edentulous Patient: A Literature Review. *J Indian Prosthodont Soc*. 2011;11(1):7–13.
5. Hall WR. Shapes and Sizes of Teeth in American System of Dentistry. Philadelphia: Lea Bros. & Co; 1887. p. 971.
6. Berry FH. Is the theory of temperaments the foundation of the study of prosthetic art. *Dent Mag*. 1905;1(405):6.
7. Kern BE. Anthropometric parameters of tooth selection. *J Prosthet Dent*. 1967;17(5):431–7.
8. Tandale UE, Dange SP, Khalikar AN. Biometric relationship between intercanthal dimension and the widths of maxillary anterior teeth. *J Indian Prosthodont Soc*. 2007;7(3):123–5.
9. Deogade SC, Mantri SS, Sumathi K, Rajoriya S. The relationship between innercanthal dimension and interalar width to the intercanine width of maxillary anterior teeth in central Indian population. *J Indian Prosthodont Soc*. 2015;15(2):91–7.
10. Patel J, Sethuraman R, Naveen YG, Shah MH. A comparative evaluation of the relationship of inner-canthal distance and inter-alar width to the inter-canine width amongst the Gujrati population. *J Adv Oral*. 2011;2(3):31–8.

11. Ellakwa A, Mcnamara K, Sandhu J, James K, Arora A, Klineberg I, et al. Quantifying the Selection of Maxillary Anterior Teeth Using Intraoral and Extraoral Anatomical Landmarks. *J Contemp Dent Pract*. 2011;12(6):414–21.

12. Scandrett FR, Kerber PE, Umrigar ZR. A clinical evaluation of techniques to determine the combined width of the maxillary anterior teeth and the maxillary central incisor. *J Prosthet Dent*. 1982;48(1):15–22.

13. Shahid F, Alam MK, Khamis MF. Maxillary and mandibular anterior crown width/height ratio and its relation to various arch perimeters, arch length, and arch width groups. *Eur J Dent*. 2015;9(4):490–9.

14. Solomon EG, Arunachalam KS. The incisive papilla: a significant landmark in prosthodontics. *J Indian Prosthodont Soc*. 2012;12(4):236–47.

15. Pachore N, Bhakhar V, Patel J, Patel A, Adeshra K. An In-vivo Comparison of Vertical and Horizontal Distance between Incisive Papilla and Incisal Edge of Maxillary Central Incisors in Dentates with Different Arch Forms. *J Clin Diagn Res*. 2017;11(4):97–100.

16. Guldag MU, Büyükkaplan US, Sentut F, Ceylan G. Relationship between pterygomaxillary notches and maxillary anterior teeth. *J Prosthodont*. 2010;19(3):231–4.

17. Baker PS, Morris WJ, Lefebvre CA, Price GA, Looney SW. Relationship of denture cast measurements to width of maxillary anterior teeth. *J Prosthet Dent*. 2011;105(1):44–50.

18. Shrestha A, Mathema S, Maharjan S, Kam S. Dimensional Relationship between Maxillary Anterior Teeth and Inter Hamular Distance. *J Nepalese Prosthodont Soc*. 2018;1(2):75–9.

Author biography

Rutu Paresh Shah, PhD Scholar and Reader, Gujarat University
https://orcid.org/0000-0002-6322-2132

Shruti Parthiv Mehta, Professor and HOD, PhD Guide, Gujarat University

Ankita Bansal, Reader