

Measurement of Inter-canthal Distance, Intertragus Distance, Bizygomatic width and Inter-alar width as a Tool for Assessment of Maxillary central Incisor Width in a Tertiary Hospital in Janakpur, Nepal

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Abstract

Introduction: Selecting maxillary anterior teeth especially central incisors is crucial for denture esthetics, with tooth width being more important than length. Esthetic dental rehabilitation significantly enhances patients' self-esteem and confidence, making it a vital part of oral rehabilitation.

This study evaluated the relationship between selected facial measurements and maxillary central incisor width in a Madhesi population to guide artificial tooth selection for edentulous patients.

Materials and Methods: The study involved 127 Nepali adults aged 20–40 years with well-aligned maxillary anterior teeth. Inter-canthal distance, inter-alar width, and maxillary central incisor width were measured using a digital Vernier caliper, while intertragus distance and bizygomatic width were recorded with an arbitrary facebow and a millimeter ruler. After obtaining informed consent, all measurements were performed by a single examiner using standardized procedures. Each measurement was recorded three times, and the mean value was used for statistical analysis. Data were analyzed using SPSS version 20.0, with significance set at $p < 0.05$.

Results: The means (standard deviations) of ICAD, ITRD, IAW, BZW, RT CW and LT CW were 30.68 (2.50), 136.05 (8.08), 35.11 (3.26), 112.90 (9.75), 8.43 (0.6036) and 8.44 (0.6332) respectively. The PC among ICD, ITRD, IAW, BZW and RT CW were 0.136, 0.162, 0.149 and 0.139 respectively. The PC among ICD, ITRD, IAW, BZW AND LT CW were 0.136, 0.145, 0.149 and 0.155 respectively. The r value among ICD, ITRD, IAW, BZW and RT CW were 0.127, 0.69, 0.95 and 0.119 respectively. The r value among ICD, ITRD, IAW, BZW AND LT CW were 0.127, 0.103, 0.95 and 0.081 respectively.

Conclusion: By assessing all the results, it was concluded that there was weak positive correlation among inter-canthal distance, intertragus distance, inter-alar width, bizygomatic width and the width of maxillary central incisor.

Keywords: Bizygomatic width; Inter-alar width; Inter-canthal distance; Intertragus distance; Maxillary central incisor.

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Introduction

Complete denture success depends on functional efficiency and esthetic harmony, achieved by matching the shape, size, and color of artificial teeth with the facial features.¹ Maxillary anterior teeth (CW) play a crucial role in dentofacial esthetics, but selecting and arranging artificial teeth for edentulous patients is challenging, especially without pre-extraction records. Proper tooth selection must harmonize with facial appearance and dentolabial relations.² Errors at this stage can often result in patient rejection of otherwise well-constructed, comfortable, and efficient dentures.³

Esthetic results are best achieved by selecting and arranging teeth according to natural principles. DeVan⁴ identified five factors influencing dental composition: position, proportion, brightness, inclination, and form. Among tooth dimensions, width is more critical than length, and knowing it helps select maxillary anterior teeth that harmonize with the edentulous face.⁵ Various guidelines have been suggested for determining the size of the teeth, but different opinions have been reported regarding their significance.^{6,7}

Berry stated that the width of the maxillary central incisor exists in a ratio of 1:16 to that of the bizygomatic width.⁸ Cesario and Latta reported that interpupillary distance could be used reliably in selecting maxillary anterior teeth width. Their measurements showed consistent relationship for sexual and racial differences.⁹ According to Al Wazzan, the inter canthal distance (ICAD) is correlated to the dental widths: the mean widths of two central incisors, the combined widths of the central incisors, the combined widths of the four incisors, and the combined widths of the six upper anterior teeth.¹⁰ According to McArthur¹¹ a patient's natural teeth and pre-extraction records are the best guides for tooth selection. In their absence, denture tooth size must be determined using facial and anatomical measurements such as interpupillary, interalar, bizygomatic, and intercanthal widths (ICAD), along with arch and soft tissue landmarks.¹²

Maxillary anterior teeth play a major role in dentofacial esthetics, yet selecting appropriately sized artificial teeth for edentulous patients is challenging, especially without pre-extraction records. This study evaluates the correlation between selected facial landmarks and maxillary central incisor width in a Madhesh population to aid clinical tooth selection.

Materials and Methods

This analytical cross-sectional study was conducted at the Department of Dental Surgery, Madhesh Institute of Health Sciences, Janakpur, Nepal, after obtaining ethical clearance (MIHS-IRC/082/083-13) and departmental permission. Written informed consent was obtained from all participants after explaining the study purpose. The sample size was calculated using the prevalence of the ideal maxillary central incisor width-to-height ratio (75–

80%) from Peixoto et al.'s photographic analysis of esthetic dental proportions.¹³

$$n = Z^2 pq / d^2 \text{ Where, } Z = 1.96$$

n = minimum desired sample size

p = prevalence of edentulism in the desired population = 20.4% = 0.204

$$q = 1 - p = 0.796$$

$$d = \text{least estimated difference of prevalence} = 0.07$$

From the above formula, the minimum desired sample size was estimated to be 127.

Participants of age 20-40 years with no missing maxillary or mandibular teeth, absence of gingival or periodontal pathology, absence of anterior restorations of any kind, no interdental spacing or crowding and with no history of orthodontic treatment was included in the study. While participants with carious, fractured and non-vital maxillary central incisor, incisor with crowns and scarring of upper lips were excluded from the study. Apart from these participants with cleft lip, nasal infection was also excluded.

This study was conducted after obtaining ethical clearance from Institutional Review Committee of Madhesh Institute of Health Sciences (MIHS-IRC/082/083-13). Permission from the department higher authorities was also obtained. After explaining the purpose and details of the research, a written informed consent was obtained from parents of all the study participants, and their information was kept confidential and anonymous.

Subjects who satisfied the inclusion criteria were selected for the study. A detailed case history was obtained. After obtaining consent from subject, the following were measured: Inter-canthal distance from inner canthus of one eye to inner canthus of the other. Inter-tragus distance from mid tragus of one side to the other. Inter-alar width from external width of the alae of the nose recorded at the widest point. Bizygomatic width is measured as the distance from zygoma to zygoma one to one and a half inches back of the lateral corner of eyes. Mesiodistal width of central incisor is measured as the widest distance between mesial and distal sides of the tooth.

All the required measurements (intercanthal distance, inter-alar width (IAW), Mesiodistal width of maxillary central incisors) were measured by vernier calipers. While bizygomatic width (BZW) was measured by a face bow and a millimeter ruler as suggested by Zarb et al. The inter-tragus distance (ITRD) was also measured by a face bow and a millimeter ruler.

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 20 for Windows (SPSS Inc, Chicago, IL). Frequency distribution analysis was performed. Descriptive statistics were used to describe the results. For each participant the mean, standard deviation, range, minimum value and maximum value of every parameter

were calculated. Pearson's correlation coefficient test was used to analyse the data.



Fig I: Materials used for the study



Fig II: Measurement of intercanthal distance



Fig III: Measurement of inter-alar width

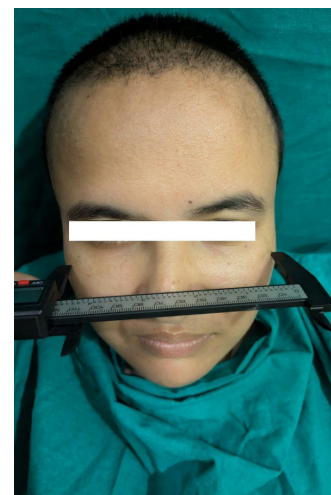


Fig IV: Measurement of bizygomatic width



Fig VIII: Position and measurement of facebow for intertragus distance measurement



Fig IX: Measurement of mesiodistal dimension of right & left central incisor

Results

Table 1,2,3 showed the mean values, standard deviation, range, minimum values and maximum values of different measurements of total samples, female and male samples respectively.

The PC showed a weak positive correlation between Intercanthal distance and for both right and left width of maxillary central incisor was statistically significant. (Table

4)

The PC showed a weak positive correlation between Intertragus distance and for both right and left width of maxillary central incisor was statistically significant. (Table 4)

The PC showed a weak positive correlation between Bizygomatic width and for both right and left width of maxillary central incisor was statistically significant. (Table 4)

The PC showed a weak positive correlation between Interalar width and for both right and left width of maxillary central incisor was statistically significant. (Table 4)

This study included total sample of 127; 63 males and 64 females. Mean $\pm$ SD of ICAD was found to be 30.68 $\pm$ 2.5 mm; ITRD 136.06 $\pm$ 8.08 mm; IAW 35.12 $\pm$ 3.26 mm; BZW 112.90 $\pm$ 9.75mm; RT. CW 8.43 $\pm$ 0.60 mm; LTCW 8.44 $\pm$ 0.63mm in total population as represented in table 1.

Table 1: Mean $\pm$ Standard deviation (SD) of study variables for total population sample (N Number=120)

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	Std. Deviation
Intercanthal distance	127	18.20	19.00	37.20	30.6866	2.50464
Intertragus distance	127	33.30	122.20	155.50	136.0583	8.08295
Interalar width	127	22.80	22.10	44.90	35.1175	3.26047
Bizygomatic width	127	108.10	23.30	131.40	112.9018	9.75801
Right central incisor width	127	3.00	6.80	9.80	8.4315	.60365
Left central incisor width	127	3.00	6.80	9.80	8.4433	.63328

The mean of Intercanthal distance for male was 30.94 mm (Millimeter) and for female was 30.43 mm. The mean of Intertragus distance for male was 139.28 mm and for female was 132.87 mm. The mean of Interalar width for male was 36.78 mm and for female was 33.48 mm. The mean of Bizygomatic width for male was 113.64 mm and for female was 112.16 mm. The mean right central incisor width for male was 8.54 mm and for female was 8.31 mm. The mean of left central incisor width for male was 8.57 mm and for female was 8.31. The mean and standard deviation of parameters according to gender is represented in table 2 and table 3 respectively. Comparative analysis of different parameters according to gender is represented by Fig 1.

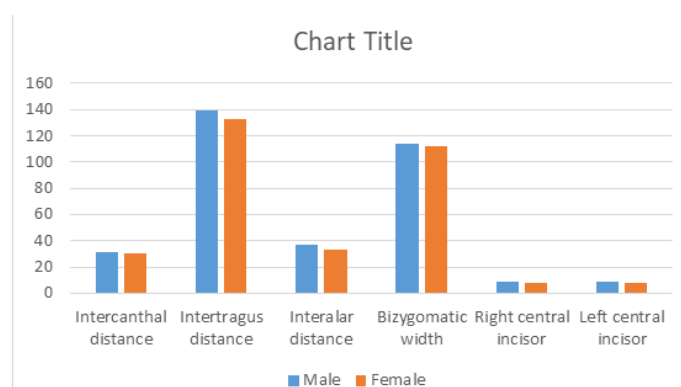


Figure 1: Comparative Graph of Mean (in mm) of different parameters according to sex.

Table 2: Mean $\pm$ Standard deviation of study variables for female population sample (N=64)

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	Std. Deviation
Intercanthal distance	64	15.90	19.00	34.90	30.43	2.51
Intertragus distance	64	28.50	122.20	150.70	132.87	6.68
Interalar width	64	18.30	22.10	40.40	33.48	2.69
Bizygomatic width	64	19.0	103.0	122.0	112.16	4.12
Right central incisor width	64	2.60	7.10	9.70	8.31	0.58
Left central incisor width	64	2.60	7.10	9.70	8.31	0.60

Table 3: Mean $\pm$ Standard deviation of study variables for male population sample (N=63).

Descriptive Statistics						
	N	Range	Minimum	Maximum	Mean	Std. Deviation
Intercanthal distance	63	12.30	24.90	37.20	30.94	2.49
Intertragus distance	63	32.40	123.10	155.50	139.28	8.14
Interalar width	63	14.30	30.60	44.90	36.78	2.94
Bizygomatic width	63	108.10	23.30	131.40	113.64	13.23
Right central incisor width	63	3.00	6.80	9.80	8.54	0.60
Left central incisor width	63	3.00	6.80	9.80	8.57	0.64

Correlation coefficient “r” value among ICD, ITRD, IAW, BZW and RT CW was 0.127, 0.69, 0.95 and 0.119 respectively. The “r” value among ICD, ITRD, IAW, BZW AND LT CW were 0.127, 0.103, 0.95 and 0.081 respectively and p- value (<0.01) among ICD, ITRD, IAW, BZW and RT .CW were 0.136, 0.162, 0.149 and 0.139 respectively. The Pearson’s coefficient among ICD, ITRD, IAW, BZW AND LT. CW were 0.136, 0.145, 0.149 and 0.155 respectively.

The Pearson’s coefficient showed statistically significant but weak positive correlation between ICAD and both right and left width of maxillary central incisor was statistically significant. Similarly, weak positive correlation was seen while correlating ITRD, BZW, and IAW with width of both right and left maxillary central incisor, which was found to be statistically significant (Table 4).

Table 4: Correlation between intercanthal distance, intertragus distance, bizygomatic width, inter-alar width, right and left maxillary central incisor width.

Correlation		Right central incisor	Left central incisor
Intercanthal distance	Pearson Correlation	0.136	0.136
	Sig. (2-tailed)	0.127	0.127
Intertragus distance	Pearson Correlation	0.162	0.145
	Sig. (2-tailed)	0.069	0.103
Interalar width	Pearson Correlation	0.149	0.149
	Sig. (2-tailed)	0.095	0.095
Bizygomatic width	Pearson Correlation	0.139	0.155
	Sig. (2-tailed)	0.119	0.081

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

Aesthetics is a primary concern in prosthodontic treatment, and achieving a natural-looking complete denture is challenging. The selection of anterior teeth plays a crucial role in determining denture aesthetics.¹⁴ Engelmeier suggested that anterior tooth width should be selected based on facial proportions; however, preoperative records are rarely available in completely edentulous patients.¹⁵

A number of anthropometric parameters have been suggested and being followed for many years to select the proper size of artificial teeth.^{6, 7, 16, 17}

Anthropometric measurements by previous investigators were either recorded directly on the anatomical land marks, on the dental casts obtained from the impression, by using calipers like devices and various other techniques.^{18, 19, 20, 21}

Similar studies^{22, 23} have been conducted by various investigators. However, none of them have proved any significant relationship between the anthropometric measurements and the width of the natural teeth.

It is obvious that all the anthropometric measurements have been recorded on movable and changeable soft tissues.²⁴ Studies made by using hard tissues like skeletal features and teeth i.e. by using x-rays will not be practicable.⁹ After 20–21 years of age, growth stabilizes and some anatomical landmarks remain constant; however, measurements taken on movable soft tissues may change with weight variation, limiting the establishment of significant correlations.¹

It is a general observation that the human body maintains some symmetry. The growth of different parts of the body takes place in proportion to each other.²⁵ After growth completion, weight changes may alter body proportions, whereas measurements from non-changeable tissues remain stable. Tooth width changes mainly in old age due to wear, with minimal wear in younger individuals.¹

With this background, this investigation was undertaken to find the relationship between of intercanthal distance, intertragus distance, bizygomatic width and inter-alar width and the width of maxillary central incisor teeth among the age group of 20-40 years. 127 samples were selected, 63 were males and 64 were females and their origins were from the madhesh population.

In the present study, the mean value width of both right and left maxillary central incisors (CW) was found to be 8.43 ± 0.60 with minimum of 6.80mm and maximum of 9.80mm and 8.43 ± 0.63 with minimum of 6.80mm and maximum of 9.80mm respectively as shown in Table 1. The highlighted results in the present study compares favorably with measurements reported by Naeem and colleagues²⁶, Isa and colleague²⁷, recorded CW on gypsum cast and Al Wazzan¹⁰, Abdullah²⁸, Hasanreisoglu²⁹ and Sulun³⁰ recorded CW intra orally and found mean value to be 8.70mm, 8.54mm, 8.48mm, 8.77, 8.6 and 8.39mm respectively which is within the range of CW value in this study. Earlier studies such as by Magne et al³¹ that recorded measurements on extracted teeth found that width by approximately 9.10mm.

In this study, the mean values of width of maxillary central incisors (CW) was found to be for male was $8.54 \text{ mm} \pm 0.60$ (right CW), $8.57 \text{ mm} \pm 0.64$ (left CW) as shown in Table 3 and the mean values of width maxillary central incisors (CW) was found to be for female was 8.31 ± 0.58 (right CW), 8.31 ± 0.60 (left CW) as shown in Table 2. Gender based difference in mesiodistal width mean was reported by previous investigators like Garn et al,³² cesario et al,⁹ MA Abdullah,²⁸ Gillen et al,³³ Sterrett et al³⁴ and Al Wazzan K10 Which is contradict to the finding by Al- kaisy and Garib³⁵ where higher mean incisor width was found for female than male.

The mean value of intercanthal distance (ICAD) was found to be 30.68mm (SD 2.50) with minimum value of 19.00mm and maximum of 37.20mm (Table 1). Abdullah and colleague²⁸ reported mean ICAD to be 32mm and Wazzan¹⁰ reported mean of 31.92mm with a range from 25.00mm to 39.00mm. Gomes and colleague³⁶ showed the median of 34.39mm ranging from 28.86 to 44.26mm. Lucas and colleague³⁷ found a similar mean of 34.426mm ranging between 28.86mm and 44.26mm for ICAD in Brazilian subjects and Isa and colleague²⁷ found similar value as this study i.e 34.36mm in sixty Malaysian adults.

The mean value of intertragus distance (ITRAD) was found to be 136.05mm (SD 0.08) with the minimum value of

122mm and maximum value of 155mm (Table 1).

The mean value of inter-alar width (IAW) was found to be 35.11mm (SD 3.26) with minimum of 22.10mm in and maximum of 44.90 mm in in total population (Table 1). Mean value of IAW was 38.27 mm, similar to this study was recorded by Ellakwa and colleague³⁸ on 120 subjects measured from photograph using digitally calibrated software. Latta and colleagues¹⁶ found a mean of 43.93 mm in edentulous patients from North America, ranging from 29.00 to 63.00 mm, Gomes and colleagues³⁶ found a mean 41.22mm, recorded from standardized digital photographs of 81 dentate. Wazzan and colleagues³⁹ measured IAW on 439 Saudi patient and found mean value to be 37.59 mm and Hoffman and colleagues⁴⁰ found 34.28mm on 340 subjects.

The mean value of bizygomatic width (BZW) was found to be 112.90mm (SD 9.75) with minimum of 23.30mm and maximum of 131.40 mm (Table 1). Rawat and colleagues³⁵ found mean value of 119.09 mm on 100 subjects.

A weak positive correlation was observed between intercanthal, intertragus, inter-alar, and bizygomatic widths and the mesiodistal width of both right and left maxillary central incisors, with low correlation coefficients and no statistically significant association (Probability)p-value (<0.01) among ICD, ITRD, IAW, BZW and RT CW were 0.136, 0.162, 0.149 and 0.139 respectively. The PC among ICD, ITRD, IAW, BZW AND LT CW were 0.136, 0.145, 0.149 and 0.155 respectively. (Table 4). Wazzan⁴¹ found significant correlation in all subjects (0.303), male (0.366) and females (0.274) at 0.01 level. Patel⁴² found no correlation in males (-0.002) while positive correlation in females. Gomes and colleague³⁶ found a significant correlation between ICAD and CW to the combined mesiodistal width of six teeth using the Spearman rank correlation coefficient. Lucas and colleague³⁷ found correlation between ICAD and CW where the value of Pearson's correlation coefficient was 0.302 (p value 0.006).

Variations among studies may be due to differences in measurement methods, ethnicity, and sample size. Harmonizing facial and dental proportions aids emotional rehabilitation after tooth loss, and this method helps predict anterior tooth width for improved esthetics in Janakpur, Madhesh Province, Nepal.

The present study also has limitations. First of all, the sample size was small and there was no other ethnicity included. No assessment of skeletal relationship was done. It was conducted on the individuals of the selected age group 20 to 40 years and further studies can be conducted including few more age group. Minor positional differences that can occur during measurement, might have affected the measurement.

Conclusion

This study evaluated the relationship between intercanthal distance, intertragus distance, inter-alar width, and bizygomatic width with the right and left widths of the maxillary central incisor. Based on the observations, statistical analysis, and discussion, a weak but statistically significant positive correlation was found between these facial measurements and the width of the maxillary central incisor on both sides.

It may be concluded that these facial measurements can be used as an aid in estimating the width of the maxillary central incisor in the Madeshi population of Janakpurdham. However, the correlations observed were weak and demonstrated only a negligible positive relationship. Owing to the limited predictive value, these measurements should be regarded solely as supplementary guidelines or preliminary references when selecting artificial teeth in the absence of pre-extraction records. The final determination of tooth size should be made during the trial insertion stage and confirmed in consultation with the patient.

Integrity and compliance statements

Ethics approval

Approved by the Institutional Review Committee of Madhesh Institute of Health Sciences (Ref: MIHS-IRC/082/083-13) on 7th Sept 2025.

Informed consent

Written informed consent was obtained from all participants for data collection and publication of anonymized data.
Trial registration (if applicable) Not applicable (descriptive cross-sectional study design).

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Conflict of Interest

The authors declare no competing interests.

Data availability

No datasets were generated or analyzed for this study.

Provenance and Peer Review

Not commissioned; externally peer reviewed. Double-blind peer review.

AI/LLM disclosure

No AI-assisted tools were used in this manuscript.

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Resha Sharma: Design, concept, data collection, literature search, manuscript review and editing.

Mukesh pandey: Design, concept, data collection, literature search, manuscript review and editing.

Anil Kumar Yadav: Concept, literature search, manuscript review and editing.

Pradip Kumar Yadav: Design, concept, literature search, manuscript review and editing.

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