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Original Article

Determination of mesiodistal width of maxillary anterior teeth using inner canthal distance

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ABSTRACT

Background: Selection of appropriately sized maxillary anterior teeth is one of the important aspects of complete denture prosthodontics. In the past several methods have been proposed, but little consensus on an effective method for anterior teeth selection has been reached. Inner canthal distance is one of the reliable anatomic dimension that may provide a valid approach to anterior teeth selection. This study was aimed to ascertain the correlation between inner canthal distance (ICD) and combined mesiodistal width of maxillary anterior teeth.

Method: This study was conducted in Army Dental Centre (R & R) Delhi Cantonment between Aug 2006 to Mar 2008. Eight hundred dentate Indian subjects of four different ethnic group; Such as Rajputs, Marathas, Sikh and Tamilian. 100 males and 100 females from each race under the age group of 18–30 years formed the subjects of study. The ICD and mesiodistal width of maxillary anteriors were measured using Digital Vernier Caliper. The Data obtained was statistically analyzed.

Results: A consistent ratio of 1.61 was found between ICD and combined mesiodistal width of maxillary anteriors in all four ethnic group. The mean value showed no statistically significant difference between sex. The variation in the ratio between the ethnic groups was negligible.

Conclusion: The findings of the study indicated that, to select the combined mesiodistal width of maxillary anterior teeth, ICD of the required patient should be multiplied by 1.61. This ratio was consistent with all the four ethnic groups irrespective of sex.

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Introduction

Esthetics plays a crucial role in complete denture prosthodontics. One of the important tasks in esthetic dentistry is the creation of harmonious smile. To achieve a harmonious smile,

the prosthodontist has to carefully blend the science and art with regards to selection and arrangement of teeth. The selection of teeth for an edentulous patient thus becomes a key facet in complete denture fabrication. In this selection process, the dentist must envisage the characteristics of beauty and other physical values of the edentulous patients and translate

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these into an acceptable esthetic result. The size, form and color of the teeth must be in harmony with surrounding oral and facial structures.¹ Selection of appropriately sized teeth requires both artistic skill and scientific knowledge. One of the primary concerns in denture esthetics is the selection of suitable sized maxillary anterior artificial teeth.

In the early part of 19th century most methods involved “hunt and peck” or “trial and error” until the patient and dental surgeon were satisfied with particular size of a tooth.² A more systematic and scientific approach is required while selecting teeth for edentulous patients. It is well understood that to look pleasing, the maxillary anterior teeth should be in proportion to facial morphology. Hence anatomic measurements such as the intercommissural width, interalar width, bizygomatic width, sagittal cranial diameter, interpupillary width have been proposed in an attempt to quantify the selection of anterior teeth for complete dentures. But these anatomical measurement have shown little consensus over the period to be an effective method in anterior teeth selection. And also all these anthropometric measurements proposed focused their attention only on the ratios between the measured distance of various anthropometric parameters and the width of the maxillary central incisors, however they have not been evaluated with geometric progression to determine proportionality between anatomic landmarks and maxillary central incisors width.

One of the anthropometric measurements of face is the distance between the inner canthus of the eyes. The inner canthal distance (ICD) is the distance between the medial angles of the palpebral fissures bilaterally. It has been reported that 78 percent of the adult ICD has been attained by 1 year of age, after which the rate of growth in this area markedly slackens in contrast to that of outer orbital dimension.³ This makes ICD a reliable anatomic dimension that may provide a valid approach to anterior teeth selection.

In a country like India we find different ethnic groups with the different physical characteristics. Hence a study for particular group may not suffice to get appropriate data in determining exact relationship between innercanthal distance and maxillary anterior artificial teeth. Hence a study was undertaken to correlate the relationship between the ICD and mesiodistal width of upper anterior teeth of among four ethnic groups in Indian population.

Materials and method

This study was conducted on eight hundred dentate Indian subjects of four different ethnic groups; that are Rajputs, Marathas, Sikhs and Tamilians. 100 males and 100 females from each ethnic group totaling upto 800 subjects under the age group of 18–30 years, after obtaining their consent, were randomly selected to form the subjects of the study.

Inclusion and exclusion criteria considered to select subjects for the study includes;

Inclusion criteria

1. No missing maxillary anterior teeth and 1st premolars.
2. No interdental spacing or crowding.

3. No dental caries or any other therapy which alter the tooth-to-tooth relation.
4. No facial asymmetry.
5. No history of orthodontic treatment.

Exclusion criteria

1. Apparent loss of tooth structure due to caries, fracture, attrition or restorations.
2. Teeth restored to correct interdental spacing or malformations.
3. Evidence of any dental irregularities like crowding, mal-formed teeth, microdontia or macrodontia.
4. Asymmetric face especially any surgical correction of orbital structures.

Materials used for this study includes (Fig. 1):

1. Digital vernier caliper (Nakamura Corp; Code 500-142).
2. Cheek retractor.

For measuring the ICD, Subjects were seated in a dental chair with their heads supported in an upright position so that they looked forward at the horizon. The digital caliper was placed against the forehead and lowered towards the eyes. The external arms of the digital caliper were adjusted so that they were in gentle contact with medial angles of the palpebral fissures of the eyes and the slide of the digital caliper was locked (Fig. 2). The distance between these two anatomical landmarks was recorded as the ICD represented in millimeters. Three reading of inner canthal distance were made and the values were averaged.

The mesiodistal widths of each maxillary central incisor, lateral incisor and canine were recorded intraorally. The widths were measured using internal jaws of the digital

Fig. 1 – Materials and equipments used for the study.

Fig. 2 – Measuring inner canthal distance using digital vernier calliper.

caliper. The beaks of the internal jaws of the digital caliper were thinned to facilitate proper fit in the labial embrasures. Cheek retractors were used for ease of accessing. The measurements were made with the pointed beaks of the internal jaws of the digital caliper placed in labial embrasures at the widest mesiodistal dimension of each tooth and the long axis of the digital caliper held parallel to the incisal edges and also the internal and external jaws of digital caliper were positioned perpendicular to the long axis of the tooth (Figs. 3–5). The locking screw was tightened making sure that beaks of the digital caliper did not move apart during recording the width of the teeth. Three measurements per tooth were made and their mean was calculated and all the measurements were tabulated. The values obtained for all 800 subjects were tabulated.

The combined width of maxillary anteriors were calculated by summing up the widths of central incisors, lateral incisors and canine of both contra lateral sides. Then the combined width of maxillary anteriors was co-related with the ICD. The observations obtained were charted and were then subjected to statistical analysis.

Fig. 3 – Measuring width of maxillary left central incisor using digital vernier calliper.

Fig. 4 – Measuring width of maxillary right lateral incisor using digital vernier calliper.

Results

The data collected and analyzed for all ethnic groups are depicted in Tables 1–3. It is apparent that the mean combined width of maxillary anteriors for females were found to be lesser than the mean values for males. The lowest and the highest values were found to be 41.98 mm and 55.25 mm with the mean of 48.85 mm. Mean values between the entire subjects, ethnic groups and sex shown statistically significant difference.

The mean ratio between ICD and combined width of upper anteriors in all subjects was found to be 1.61 mm. The mean ratio was consistent with all ethnic group as depicted in Graph 1. There was no statistically significant difference apparent between the means of entire subjects. The minimum and maximum ratio was found to be 1.23 mm and 2.28 mm.

Fig. 5 – Measuring width of maxillary right canine using digital vernier calliper.

Table 1 – Inner canthal distance.

	Mean	Min	Max	95% CI lower bound	95% CI upper bound	SD	'P' value
All subjects							
All subjects	30.23	26.89	36.51	30.13	30.34	1.51	<0.01
Males	30.79	27.13	36.51	30.66	30.92	1.35	<0.01
Females	29.67	26.89	32.83	29.53	29.82	1.45	0.069
Males							
Rajputs	30.43	28.18	33.09	30.19	30.67	1.22	<0.01
Sikhs	31.34	27.45	35.79	31.07	31.61	1.35	<0.01
Tamilians	30.71	27.79	36.51	30.43	30.92	1.43	<0.01
Marathas	30.68	27.13	33.09	30.43	30.92	1.25	<0.01
Females							
Rajputs	29.75	27.12	32.83	27.12	32.83	1.39	<0.01
Sikhs	29.95	27.15	32.43	27.15	32.43	1.48	<0.01
Tamilians	29.52	26.89	32.70	29.25	29.80	1.38	<0.01
Marathas	29.47	27.41	32.83	29.17	29.77	1.52	<0.01

Discussion

Enhancement of facial beauty is one of the primary elective goals of patients seeking dental care. Loss of teeth especially anterior teeth is a traumatic experience that prompts people to seek dental care. Hence the planned prosthesis should fulfill esthetic harmony, functional efficiency and structural balance with the rest of the dentofacial structures. Achieving excellent esthetics when restoring or replacing the maxillary anterior teeth is one of the most challenging tasks in dentistry. Hardy IR had stated that, "To meet the esthetic needs of the denture patient, we should make the (denture) teeth look like (the patient's) natural teeth."⁴

In complete denture construction, selection of anterior teeth is a vital step. When no pre-extraction records are available, selecting the proper size and shape of anterior teeth for edentulous patients can be difficult. A systematic approach is needed in selecting size of anterior teeth. Various anatomic measurements were been suggested, which includes the bizygomatic width, interpupillary distance, interalar width and intercommissural width as guidelines for selection of teeth.

One of the anthropometric measurements of face is the distance between the inner canthus of the eyes. Canthus

(Greek word 'Kanthos': corner of the eye) is an angle or corner on each side of the eye, formed by the union of the upper and lower lids. The medial junction of the 2 eyelids is called the medial angle (medial canthus). The ICD is the distance between the medial angles (canthi) of the palpebral fissure bilaterally. Laestadius and co-workers³ has reported that 78 percent of the adult ICD is attained by 1 year of age; subsequently the rate of growth in this area reduces in contrast to that of the outer orbital dimension. The intercanthal width reached full maturation at 8 years in females and 11 years in males. In comparison with other skeletal structures, the orbital measurements showed more advanced early development and less subsequent growth than the forehead and bizygomatic widths. All these factors make ICD a reliable anatomic dimension that may provide a valid approach to anterior teeth selection. The relative stability of the ICD aroused interest in various authors who have reported using ICD as the anatomic landmark in determination of mesiodistal width of central incisor and upper anterior teeth.^{5–7} These studies were conducted for limited sample size and for a single ethnic group. The authors of these studies were of an opinion that, the ethnic related differences in ICD may exist and they proposed further research to validate the relationship between ICD and maxillary central incisors and maxillary anteriors.

Table 2 – Combined width of upper anteriors.

	Mean	Min	Max	95% CI lower bound	95% CI upper bound	SD	'P' value
All subjects							
All subjects	48.85	41.98	55.25	48.68	49.02	2.44	<0.01
Males	49.69	43.98	55.25	49.47	49.92	2.27	<0.01
Females	48.00	41.98	53.04	47.77	48.23	2.32	<0.01
Males							
Rajputs	49.45	44.46	54.29	49.06	49.85	1.98	<0.01
Sikhs	50.94	44.65	55.01	50.50	51.37	2.17	<0.01
Tamilians	49.51	44.08	55.25	49.07	49.94	2.20	<0.01
Marathas	48.88	43.98	52.93	48.43	49.32	2.22	<0.01
Females							
Rajputs	47.32	43.05	52.63	46.85	47.80	2.40	<0.01
Sikhs	48.27	41.98	52.30	45.80	48.74	2.37	<0.01
Tamilians	48.08	43.92	53.04	47.68	48.52	2.11	<0.01
Marathas	48.32	43.44	52.50	47.87	48.77	2.28	<0.01

Table 3 – Ratio between inner canthal distance and combined width of upper anteriors.

	Mean	Min	Max	95% CI lower bound	95% CI upper bound	SD	'P' value
All subjects							
All subjects	1.61	1.23	2.28	1.60	1.61	0.06	<0.01
Males	1.61	1.39	2.28	1.60	1.62	0.07	0.013
Females	1.61	1.23	1.78	1.60	1.61	0.05	<0.01
Males							
Rajputs	1.62	1.44	1.76	1.61	1.63	0.06	<0.01
Sikhs	1.63	1.43	2.28	1.61	1.65	0.09	<0.01
Tamilians	1.61	1.39	1.80	1.60	1.62	0.06	<0.01
Marathas	1.59	1.45	2.28	1.58	1.61	0.08	<0.01
Females							
Rajputs	1.58	1.23	1.70	1.57	1.59	0.05	<0.01
Sikhs	1.61	1.49	1.78	1.60	1.62	0.05	<0.01
Tamilians	1.62	1.50	1.75	1.62	1.63	0.04	<0.01
Marathas	1.62	1.52	1.72	1.61	1.62	0.04	<0.01

A search of literature reveals that, hardly any study of this type been carried out in Indian population. The present study aimed at the determination of mesiodistal width of central incisors and upper anteriors using ICD in four ethnic groups (Rajputs, Sikhs, Marathas and Tamilians) of both sexes of Indian origin. This study also correlated, whether combined width of maxillary central incisors and ICD are in geometric progression in all the subjects studied.

ICD was chosen for measurement in the present study for the following reasons:

- Studies have proved that the reference points (namely, medial angles of the palpebral fissures of the eyes) as a stable anthropometric parameter.
- These reference points can be easily located and measured with a simple instrument such as vernier caliper.

Limitations of using caliper as a measuring device was noticed during the study which includes, inability to insert the thinner beaks of the caliper in the broadest width of the tooth due to tight teeth contacts, some subjects did not co-operate to place the beaks of the caliper in the medial canthus to record ICD, incorporation of errors would have been significant if more than one operator recorded the measurements.

It was observed that, all tooth dimensions and ICD were significantly larger in men than in women. This is in

consistent with the previous studies.^{8–10} All the measured and calculated mean values were more consistent in females than in males. An analogous report in this regard was also been stated by Mavroskoufis et al.¹¹

Combined width of upper anteriors is the sum total width of each anterior tooth. Most of the values (95% confidence interval) of this parameter ranged between 48.68 mm and 49.02 mm with the mean being 48.85 mm. Rajput women showed highest and lowest values of 52.63 mm and 43.05 mm respectively between the ethnic groups of same sex. The highest and lowest values recorded for all 800 subjects examined were 55.25 mm and 41.98 mm respectively. Mean values of CWUA between ethnic groups and sex showed statistically significant difference. The mean value of CWUA (48.85 mm) found in present study was less than the value reported by Scandrett et al.¹² (53.61 mm) and greater than the values reported by Wazzan⁸ (45.23 mm) and Shillingburg et al.¹³ (45.80 mm). This variation in the measurements reported could be attributed to the difference in the ethnicity of the population evaluated.

The relationship between ICD and combined width of upper anterior a ratio between ICD and CWUA was found. The overall mean ratio between ICD and CWUA was found to be 1.61 with the maximum and minimum ratio being 2.28 and 1.23. The lowest mean ratio of 1.23 was found in Rajput female subjects. The mean value showed no statistically significant difference between sex. The variation in the ratio between the ethnic groups (0.01) was negligible. This indicates that the width of upper anteriors can be obtained by multiplying ICD with 1.61. This ratio is slightly more than the ratio quoted by Wazzan (1.426).⁸ This variation in the ratio may also due to difference in the ethnicity of the sample population tested.

Conclusion

This study attempted to correlate the width of maxillary anteriors using ICD. The mean ratio found in our study was 1.61 ($p = <0.01$); which is irrespective of sex or racial difference. Hence to determine the combined width of maxillary anterior in edentulous patients, ICD should be multiplied with 1.61 for the Indian populace.

Graph 1 – Comparison graph indicating mean ratio between Inner canthal Distance & Mesio-distal width of maxillary anteriors among all ethnic groups of both the sex and overall ratio of all subjects.

This study included only four ethnic groups (Rajput, Sikh, Maratha and Tamilian) of both the sexes. Further research is required with the inclusion of other ethnic groups of Indian population, so that the results obtained can be universally applied to all Indian population.

Conflicts of interest

All authors have none to declare.

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