

Relationship of Inter-Condylar Distance With Inter-Dental Distance Of Maxillary Arch and Occlusal Vertical Dimension: A Clinical Anthropometric Study

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ABSTRACT

Aim: To find out the anthropometric relationship of Inter-condylar distance to Inter-canine and Inter-molar distance of maxillary arch and occlusal vertical dimension in dentate individuals of South Indian population.

Materials and Methods: A total number of 120 dentate individuals were randomly divided into Group A and Group B. According to the face form, each Group was again subdivided into four subgroups. Subgroup A1 and B1 contained Square face form, Subgroup A2 and B2 Tapered, Subgroup A3 and B3 Square tapered and Subgroup A4 and B4 Ovoid face form. The ratio of ICD to U3, U6 and OVD of Group A individuals were applied to the Group B individuals with similar face forms and the clinical significance of the ratios were evaluated.

Results: No significant difference (p -value=0.841) was observed in the ratio of U6 to ICD (U6/ICD) in all the face forms. A significant difference (p -value = 0.010) in the mean value was observed when the ratio of OVD to ICD (OVD/ICD) was compared between the squared tapered face form of Group A (0.60 ± 0.01) and Group B (0.06 ± 0.03). A significant difference (p value = 0.007) was observed between the measured (62.47 ± 2.77) and calculated (64.99 ± 2.61) values of OVD in square taper face form.

Conclusion: In south Indian population, ICD can be used as a reliable guide line to determine the bucco-palatal position of maxillary first molar irrespective of the face forms.

Keywords: Denar posterior reference points, External auditory canal, Face form, Outer canthus of eye, Willis gauge

INTRODUCTION

Face is the most expressive part of human body. Most often it determines the individual's social acceptance. Esthetically pleasing and functionally comfortable replacement of the missing teeth improves the individual's facial appearance and masticatory efficiency [1].

Over the years, norms, criteria and guidelines for proper tooth selection and arrangements have been suggested by the artisans of dental profession. However the selection and arrangement of teeth for edentulous patients in a natural and aesthetically pleasing form and function has remained an elusive and challenging endeavor. No universally acceptable method has been established to meet this end. Dentists seek guidance from various techniques using their clinical expertise and aesthetic sense to attain acceptable results.

There are many subtle manifestations of the proportions in nature. It is applicable for human body also. The various parts of the human body are proportionately related to each other [2-11]. El-Gheriani et al., found that the position of the upper posterior teeth has a constant relationship with the lateral arm of the Gothic arch tracing or Inter-canine distance [12,13]. Keshvad et al., has proposed that the ICD could be used as a reliable guideline for complete denture teeth arrangement [14].

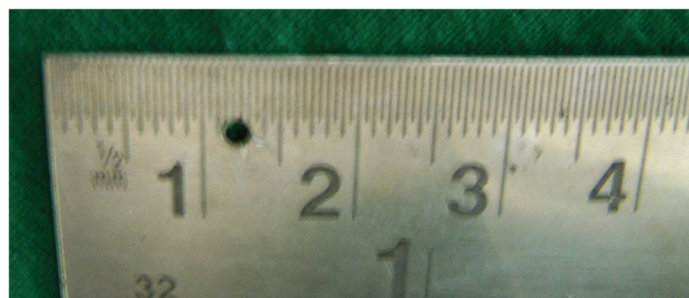
The proper teeth arrangement and OVD are the key elements contributing to the dento-facial beauty of edentulous patients. In the literature many anthropometric studies have been done to standardize the tooth position in dental arch but most of the studies were concerned for anterior teeth. Very few studies have examined the scientific methods for determining the positioning of posterior teeth in complete dentures. To the best of Authors knowledge, there has been no clinical anthropometric study done in Indian

population to determine the importance of ICD as a guideline for complete denture fabrication. Hence, this study was conducted to find out the correlation of ICD with U3 and U6 and OVD in dentate individuals of South Indian population.

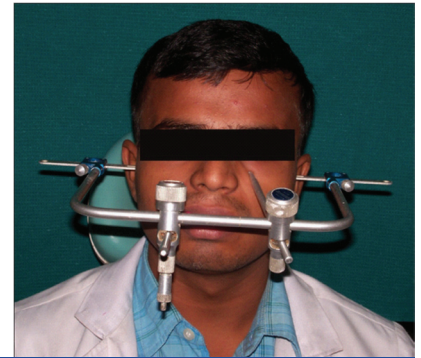
MATERIALS AND METHODS

The study was undertaken in Tamil Nadu Govt. Dental College and Hospital, Chennai, with the permission of Institutional Ethical Committee. A total of 120 dentate south Indian individuals were selected for the study. The inclusion criteria's were age group of 25-40 years, dentate individuals with the presence of all natural teeth and Class I occlusion. Individuals with any kind of malocclusion, retained teeth, facial asymmetry and history of attrition, abrasion, TMJ pain or Orthodontic and Prosthodontic treatment were excluded from the study.

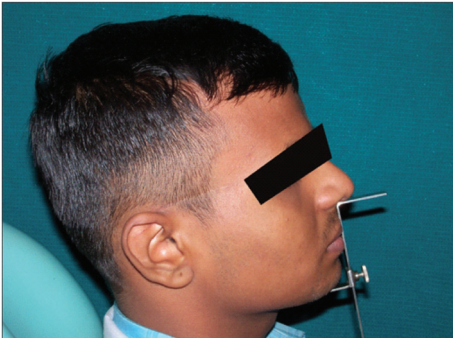
A point 12 mm anterior from the middle of the superior border of External auditory canal towards the outer Canthus of eye and 5 mm down represents the Denar posterior reference point. This point is used to estimate the centre of condyle [15]. On a stainless



[Table/Fig-1]: Customised denar posterior reference point locator



[Table/Fig-2]: Placement of denar posterior reference point locator **[Table/Fig-3]:** Denar posterior reference point marked **[Table/Fig-4]:** Measurement of IFW with Dentatus facebow



[Table/Fig-5]: Measurement of OVD with willis gauge **[Table/Fig-6]:** Measurement of U3 and U6 from cast **[Table/Fig-7]:** Measurement of U3 and U6 intra-orally



[Table/Fig-8]: Measurement of OVD with divider

steel metal scale, a 0.5 mm hole is made on a selected point 12 mm anterior and 5 mm vertically down starting from one end. This scale was used as Customised Denar posterior reference point locator [Table/Fig-1]. In all the study individuals the Denar posterior reference point on either side of face was marked with this scale [Table/Fig-2,3] and the IFW in between this two posterior reference points was measured by Dentatus face bow without compressing the soft tissue [Table/Fig-4].

A pilot study was done to determine the average ICD and average soft tissue thickness between the Denar posterior point and lateral tip of condyle. A total of 20 healthy individuals who were scheduled for CT scan for any form of diagnosis and fulfilled the inclusion

criteria, were selected for the pilot study. IFW was measured with Dentatus facebow in between two Denar posterior reference point. In CT scan images ICD were measured in between the lateral tip of both condyles. The difference between the IFW and ICD represents the total intermediate soft tissue thickness on both sides. The mean intermediate soft tissue thickness was 9 mm on either side of face.

The 120 study individuals were randomly equally divided into Group A and Group B. Further each group was subdivided into four subgroups according to their face forms. Sub-Group A1 and B1 contained Square face form, Sub-Group A2 and B2 Tapered face form, Sub-Group A3 and B3 Square tapered face form and Sub-Group A4 and B4 contained individuals with Ovoid face form.

In Group A, U3 and U6 was measured extra-orally from the maxillary cast with the help of screw latched divider and measuring scale [Table/Fig-5]. The tip of cuspid and mesiobuccal tip of maxillary first molar was used as reference point. Willis gauge was used to measure the OVD from the base of the nose to the lower border of the chin when all the teeth were in centric occlusion [Table/Fig-6].

In Group B, all the subjects were seated in posteriorly reclined position and with the help of screw latched divider and measuring scale the U3 and U6 were measured intra orally [Table/Fig-7]. Similarly metallic divider was used to measure the OVD in upright position [Table/Fig-8].

In all the 120 subjects of Group A and B, ICD was calculated by subtracting the mean intermediate soft tissue thickness of 18mm from the measured IFW.

STATISTICAL ANALYSIS

All statistical analysis was performed using SPSS version 20. One-way ANOVA followed by Tukey's HSD Post Hoc Test was done to compare the ratios of U3/ICD, U6/ICD and OVD/ICD among the subgroups with different face form. Student's t-test analysis was performed to compare the ratios of U3/ICD, U6/ICD and OVD/ICD between the subgroup of similar face form. The ratio of U3/ICD, U6/ICD and OVD/ICD of Group A individuals were applied to the Group B individuals with similar face form and the measured and calculated values of U3, U6 and OVD were compared using Student t-test.

Parameters	Mean (SD)
Mean age of the study population	29.18 (2.78)
Mean inter canine distance (U3) of study population	34.68 (2.47)
Mean inter- molar distance(U6) of study population	54.78 (2.75)
Mean occlusal Vertical dimension (OVD) of study population	64.62 (2.73)
Mean Inter facial width (IFW) of study population	128.07 (4.34)
Mean inter condylar distance (ICD) of study population	109.15 (10.94)

[Table/Fig-9]: Socio demographic data

Ratio	Face form	N	Mean (SD)	P value
U3/ICD	Tapered	30	0.31 (0.02)	0.005**
	Ovoid	30	0.32 (0.02)	
	Square	30	0.32 (0.01)	
	Square Tapered	30	0.31 (0.01)	
	Total	120	0.32 (0.02)	
U6/ICD	Tapered	30	0.50 (0.02)	0.841
	Ovoid	30	0.50 (0.02)	
	Square	30	0.50 (0.02)	
	Square Tapered	30	0.50 (0.01)	
	Total	120	0.50 (0.02)	
OVD/ICD	Tapered	30	0.60 (0.02)	0.000**
	Ovoid	30	0.60 (0.02)	
	Square	30	0.58 (0.02)	
	Square Tapered	30	0.58 (0.02)	
	Total	120	0.59 (0.02)	

[Table/Fig-10]: One-way ANOVA analysis of the ratios in all the face forms
One way ANOVA, **p-value <0.05; statistically significant difference

RESULTS

The mean age of the study population was 29.18±2.78 years. The mean U3, U6, OVD, IFW and ICD were calculated as 34.68±2.47, 54.78±2.75, 64.62±2.73, 128.07±4.34, 109.15±10.94 respectively [Table/Fig-9].

No significant difference (p-value=0.841) was observed in the ratio of U6 to ICD (U6/ICD) in all the face forms. A significant difference in the mean value was observed when the ratio U3/ICD (p-value = 0.005) and OVD/ICD (p-value = 0.000) was calculated and compared among the different face form subgroups. Tukey HSD post Hoc test showed that there was statistically significant difference in the ratio of U3 to ICD (U3/ICD), in the square and tapered face form. Also, a statistical significant difference was observed in the ratio of OVD to ICD (OVD/ICD) in square to tapered and square to ovoid face form [Table/Fig-10].

A significant difference (p-value = 0.010) in the mean value was observed when the ratio of OVD/ICD was compared between the squared tapered face form of Group A (0.60 ± 0.01) and Group B (0.06±0.03). No significant differences were observed in U3/ICD, U6/ICD and OVD/ICD when compared in rest of the similar face forms of Group A and Group B (p-value >0.05) [Table/Fig-11].

A significant difference (p-value = 0.007) was observed in the measured (62.47 ±2.77) and calculated (64.99±2.61) values of OVD in square taper face form. No significant differences were found between measured and calculated values of U3, U6 and OVD in other face forms (p-value > 0.05) [Table/Fig-12].

DISCUSSION

Ideal arrangement of teeth for an edentulous patient becomes difficult in the absence of pre-extraction records. Various methods have been adopted for the ideal arrangement of teeth most of them reveals a dependence on the physical characteristics of the

dento-facial landmarks such as Inter-alar width, Bi-zygomatic width and Facial heights. Besides these, various intra oral landmarks like Incisive papilla, Inter-canine distance have also been taken into consideration for selection and arrangement of teeth [16].

Accurate Bucco-palatal position of teeth in prosthesis, in relation to the underlying supporting alveolar ridge is important for proper esthetic, function, comfort and phonetics of the patient. It also provides adequate clearance for tongue and buccal corridor space and improves the stability of the prosthesis. The ICD of human remains fairly static throughout the life [14]. In this study ICD is calculated by subtracting the intermediate soft tissue thickness from the IFW measured between the two Denar posterior reference points. John J Sharry [17] stated that the lateral tip of condyle lies about 13 mm beneath the skin surface and can be located by palpation. Stuart [18] concluded that the average distance between the skin surface and the rotational centre of condyle is about 17 mm. Denar manual [19] guideline suggested that the subtraction of 12.5 mm is needed from the skin surface to the rotational centre of the condyle as intermediate soft tissue thickness. Clayton [20] critically analyzed the accuracy of the Denar manual guidelines and proposed that the subtraction of 12.5 mm from the skin surface to the rotational centre of the condyle as intermediate soft tissue thickness is accurate only in 60% population. CB Mandilaris et al., [21] measured the ICD with pantronic face bow using Denar guideline and compared it with the recorded articulator ICD that had been set from a mechanical pantograph without Denar guidelines. Results showed that the difference between the IFW and the actual ICD was 15.1 mm on the right side and 14.9 mm on the left side with mechanical pantograph which was statistically superior to the 12.5 mm given in Denar manual guideline.

In the present study, the ICD was measured with CT scan between the lateral tip of condylar heads and IFW with Dentatus face bow between the two Denar posterior reference points. Results showed that the average unilateral soft tissue thickness between the lateral tip of condylar head to the skin surface was approximately 9 mm in South Indian population, which differs significantly from the other studies. This denotes that the intermediate soft tissue thickness is variable among the different ethnic groups of population.

According to Bhat and Gopinathan [22] the conventional methods are not as reliable as compared to the pre extraction records in determining the VDO in edentulous patients. Therefore in this study, the ratio of the OVD to calculated ICD was evaluated among various face forms. To determine the OVD, Willis gauge was used as it can be easily stabilized and accurately record the distance from the base of nose to the lower border of the chin.

The positional relationship of maxillary canine and first molar to ICD was evaluated, as their position in the dental arch acts as a guideline for arrangement of rest of the teeth.

In this study, results showed no statistically significant difference in the ratios of ICD to U3 and U6 in both the groups with similar face form (p>0.05). No significant difference (p-value = 0.841) in the ratio of U6 to ICD (U6/ICD) was observed among all the face forms. There was statistically significant difference in the U3 to ICD ratio (U3/ICD, p-value = 0.005) and OVD to ICD ratio (OVD/ICD, p value = 0.000) among the various face forms. Since the ratio of U6/ICD remains constant in all the face forms of South Indian population, the authors are of the opinion that the ICD can be used as a guideline to estimate the U6 and its bucco-palatal position, irrespective of the face forms.

In the present study, ICD was 3.17 times greater than U3, 2 times of U6 and 1.7 times greater than the OVD irrespective of the face form. Keshvad et al., [14] investigated that ICD is 3.39 times greater than U3 and 2.19 times of U6 in Sheffield population. This shows that the relationship of ICD to Inter-dental distance varies according to different racial group of population.

Face form	Ratio	Group	N	Mean (SD)	Sig. (2-tailed)	95% Confidence Interval of the Difference	
						Lower	
Square	U3/ICD	Group A1	15	0.32 (0.01)	0.227	-0.00	0.02
		Group B1	15	0.32 (0.01)			
	U6/ICD	Group A1	15	0.49 (0.02)	0.242	-0.02	0.01
		Group B1	15	0.50 (0.02)			
	OVD/ICD	Group A1	15	0.58 (0.02)	0.672	-0.01	0.02
		Group B1	15	0.57 (0.02)			
Tapered	U3/ICD	Group A2	15	0.31(0.02)	0.570	-0.01	0.02
		Group B2	15	0.31(0.02)			
	U6/ICD	Group A2	15	0.50 (0.02)	0.919	-0.02	0.02
		Group B2	15	0.50 (0.02)			
	OVD/ICD	Group A2	15	0.60 (0.02)	0.934	-0.01	0.02
		Group B2	15	0.60 (0.02)			
Square –tapered	U3/ICD	Group A3	15	0.31 (0.01)	0.703	-0.01	0.01
		Group B3	15	0.31 (0.01)			
	U6/ICD	Group A3	15	0.50 (0.01)	0.891	-0.01	0.01
		Group B3	15	0.50 (0.01)			
	OVD/ICD	Group A3	15	0.60 (0.01)	0.010**	0.01	0.04
		Group B3	15	0.60 (0.03)			
Ovoid	U3/ICD	Group A4	15	0.32 (0.02)	0.690	-0.01	0.00
		Group B4	15	0.32 (0.01)			
	U6/ICD	Group A4	15	0.50 (0.02)	0.257	-0.02	0.00
		Group B4	15	0.50 (0.01)			
	OVD/ICD	Group A4	15	0.60 (0.02)	0.630	-0.01	0.01
		Group B4	15	0.60 (0.02)			

[Table/Fig-11]: Student's t-test of the ratios in similar face forms student t test, **p- value <0.05; statistically significant difference

Face form	Group	N	Mean (SD)	Sig. (2-tailed)
Square	U3-MEASURED	15	36.53(2.07)	0.100
	U3-CALCULATED	15	37.26 (1.26)	
	U6-MEASURED	15	57.27 (2.25)	0.275
	U6-CALCULATED	15	56.63 (1.92)	
	OVD-MEASURED	15	65.60 (2.16)	0.418
	OVD-CALCULATED	15	66.12 (2.24)	
Tapered	U3-MEASURED	15	32.87 (2.35)	0.369
	U3-CALCULATED	15	33.41 (0.75)	
	U6-MEASURED	15	53.87 (2.66)	0.912
	U6-CALCULATED	15	53.80 (1.20)	
	OVD-MEASURED	15	64.20 (3.02)	0.713
	OVD-CALCULATED	15	64.43 (1.44)	
Square –tapered	U3-MEASURED	15	34.13 (2.19)	0.583
	U3-CALCULATED	15	34.34 (1.38)	
	U6-MEASURED	15	54.33 (2.35)	0.981
	U6-CALCULATED	15	54.32 (2.18)	
	OVD-MEASURED	15	62.47 (2.77)	0.007**
	OVD-CALCULATED	15	64.99 (2.61)	
Ovoid	U3-MEASURED	15	34.93(1.53)	0.554
	U3-CALCULATED	15	34.70(1.01)	
	U6-MEASURED	15	54.93(2.18)	0.166
	U6-CALCULATED	15	54.45(1.58)	
	OVD-MEASURED	15	65.13(2.41)	0.271
	OVD-CALCULATED	15	65.86(1.92)	

[Table/Fig-12]: Student's t-test comparing the measured and calculated values in Group B individuals, student t-test, **p-value <0.05; statistically significant difference

In the present study, done in South Indian population, it was found that the ICD ranges from 100 to 124 mm with a mean value of 110.07 mm. The average ICD in male and female was found as 112 and 108 mm respectively. Biserka Lazi et al., [23] measured the ICD between the centres of condyle in postero-anterior cranial radiographs of Croatian population. The ICD had the range of 110 to 145 mm, with the mean of 126 mm. There was a significant difference found between male and female. Michael Tradowsy [24] measured the ICD by means of the Minigraph and Simulator instruments. The mean ICD for men was 108 mm (SD = 7.2, SE = 0.6) and for women, 102 mm (SD = 7.4, SE = 0.6). The difference was highly significant (p < 0.0001). It was hypothesized that the adjustable articulators that have a lower limit of 90 mm, the ICD adjustment will not be possible for 5% of women having a smaller ICD. An articulator with a lower limit of 96 mm will not be adjustable for 20% of women and 5% of men. He suggested the adjustment range of 80 to 130 mm in articulator which would miss only one woman in 10,000 at the lower limit and one man in 10,000 at the upper limit.

Within the limitation of this study, it was found that with different face forms the U6 to ICD ratio remained same but the ratio of U3 and OVD to the ICD varies. So, the future study should include the correlation of face form to the palatal arch form in respect with Inter dental width. As this study was done in South Indian population alone, the universal acceptance of the ratios is questionable. Hence, comparison of the ratios among the various ethnic and racial groups can be a future study. Further studies needs to be done to evaluate the clinical acceptance of this ratio as a biometric guideline for teeth arrangement as compared to the conventional guidelines in immediate denture patients.

CONCLUSION

The average soft tissue thickness from the skin surface to lateral tip mandibular condyle and ICD to U3 and U6 ratio differs among the different racial group of population. In the present study done in South Indian population, U6 to ICD was found to be constant irrespective of the face forms, thus, ICD can be used as a reliable guideline to determine the bucco-palatal position of maxillary first molar in South Indian population irrespective of the face forms.

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