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Assessment of Inter-Condylar Distance as a guide for Arrangement of Maxillary Prosthetic Teeth

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Abstract

Background & Objectives: Inter-Condylar Distance (ICD) has been used as a reliable and fixed parameter for selection of mandibular anterior teeth and their arrangement. The objectives of this study were to determine the relationship of inter-condylar distance with maxillary inter-canine distance and maxillary inter-molar distance. **Methods:** This cross-sectional study was conducted in the Department of Prosthodontics & Crown-Bridge, B.P. Koirala Institute of Health Sciences (BPKIHS) enrolling 120 dentate subjects those fulfilled the inclusion criteria. Maxillary casts were prepared and the distance between bilateral canine tips were measured using a Vernier caliper. The mesiobuccal cusp tips of maxillary first molars were marked and the distance was measured using the caliper. Inter-condylar distance was measured using arbritary face bow. The distance between the two condylar rods was measured in millimeters using Vernier caliper. Every distance was measured three times to assure the accuracy and mean taken. Data were recorded on the proforma for statistical analysis. **Results:** The ratio of intercondylar distance to the maxillary inter-canine distance was found to be 3.6:1 whereas that to intermolar distance was 2.6:1. Pearson correlation coefficients (r) for the ICD showed positive and significant correlation to both the inter-dental distances. (r - 0.33, ($p<0.001$) for Maxillary Inter-Canine distance (MIC) and r – 0.59, ($p<0.001$) for Maxillary Inter-Molar distance (MIM). **Conclusion:** Inter-condylar distance provides significant measurements and hence can be used as a guide for maxillary denture teeth arrangement.

Keywords: Inter-Canine Distance, Inter-Condylar Distance (ICD), Inter-molar Distance, Teeth Arrangement

1. Introduction

Esthetics has been a major consideration in prosthodontic therapy that might be achieved by replacement of the lost or congenitally missing natural teeth and associated oral structures in the same positions occupied by their natural predecessors. However, the tooth loss inevitably results in the resorption of the residual alveolar ridge to some extent depending upon various mechanical, anatomical and metabolic factors[1]. The maxillary alveolar ridge migrates upwards and inwards whereas the mandibular alveolar ridge migrates downwards and outwards making the arrangement of the artificial teeth more difficult in a patient with long term edentulism[2]. Hence certain stable anatomical landmarks and their relation with the position of natural teeth can be used to arrange the artificial teeth as close to the position as their natural predecessors. Incisive papilla and various other landmarks like width of the mouth, inter-alar width, bi-zygomatic width and inter-pupillary distance have been used for arrangement of maxillary prosthetic teeth whereas retromolar pad had been frequently used as a guide for arrangement of mandibular prosthetic teeth[3-6]. Inter-condylar width has been used as a guide to set complete denture prosthetic teeth[2] and it has been found to have positive correlation with mandibular inter-canine distance. As pointed out there are studies in the literature assessing the differences in Inter-Condylar Distance (ICD), Mandibular Inter-Canine (MIC) distance and mandibular inter-molar distance with age and gender and lacunae of studies

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that assessed the correlation of these dimensions for the mandibular arch. Therefore, the current study was aimed to evaluate if ICD does correlate with Maxillary Inter-Canine (MIC) and Maxillary Inter-Molar (MIM) and could serve as a guide for prosthetic tooth arrangement in complete dentures.

2. Methodology

This cross-sectional study was conducted among the dental students and patients visiting the department of prosthodontics, BPKIHS, Nepal who met the inclusion criteria. Ethical clearance was obtained from the Institutional Review Committee. Inclusion Criteria were the age range between 21 to 40 years, Angle class-I Maxillomandibular relationship, natural maxillary teeth in good alignment, no restoration or tooth loss in maxilla, no history of orthodontic treatment/orthognathic surgery and no any facial deformity. A total of 120 participants were sampled for the study after getting their written consent.

Maxillary dental-arch impressions were made using irreversible hydrocolloid impression material (Zelgan, DENTSPLY ISO 9001) in perforated edentulous stock trays. Those impressions were poured with type III dental stone (Kalstone, India/article no. 211003) to obtain the maxillary dental casts where the damaged stone casts were excluded from the study. The ICD was measured using arbitrary face-bow (96 H2 Hanau, Buffalo, USA). Fork was attached to the teeth with Addition silicone impression material (Aquasil soft putty/regular set, DENTSPLY, Germany, ISO 4823, type 0). Hinge axis was marked 13 mm anterior to the upper border on the tragus canthus line on both sides of the face. The face-bow was then re-assembled with fork intra-orally and the condylar rods on the hinge axis marks (Figure 1). The reassembled face-bow was removed from the face without changing the positions of the condylar rods and the distance between two condylar rods was measured (Figure 2).

All measurements were made by a single examiner, with a digital Vernier calliper (Mitutoyo corp., Japan) with the precision of 0.01mm. For all measurements, the arms

Figure 1. Condylar rods of face bow touch the skin over condyles.

Figure 2. Measurement of Inter-Condylar Distance (ICD).

of the calliper were so adjusted, that they remain in contact with the extremes of what was intended to be measured. The distance between condylar rods was measured just after removal of the assembled face-bow out of face. For measurement of MIC distance and MIM distance, stone casts were used. Once the casts were ready, the canine tips and mesio-buccal cusp tips were identified and marked with a pencil. The distances between the canine tips and the mesio-buccal cusp tips were measured using the same Vernier calliper (Figure 3&4). The digital calliper was checked and rechecked for proper functioning after every ten participants using a metallic ball of diameter 4.74mm. For intra-examiner reliability, all measurements

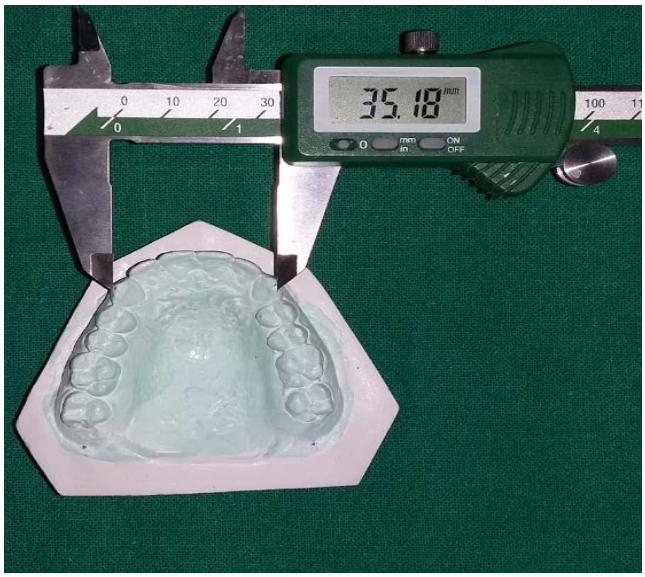

Figure 3. Measurement of Maxillary Inter-Canine (MIC) distance.

Figure 4. Measurement of Maxillary Inter-Molar (MIM) distance.

of the first twenty-five participants were repeated after a period of 10 days. The subsequently calculated kappa scores for MIC, MIM and ICD were 0.86, 0.83 and 0.72 respectively, which suggested that clinical intra-examiner reproducibility for recording variables was very good.

Total sample population was grouped into males and females and based on age group it was grouped as less than 25 years of age and more than or equal to 25 years of age. Twenty-five years was taken as cut off point as it has been suggested by Enlow and Bang that all types of sutural and appositional growth of maxilla might seize by 25 years of age[7]. Percentage, mean and standard deviation were calculated. Karl Pearson correlation coefficients were computed to examine the strength of association between the inter-condylar distance with intermolar distance and inter-canine distance. Furthermore, student t-test was applied to compare intercondylar distance, inter-canine distance and intermolar distance using the Microsoft statistical package SPSS version 11.5. Probability of significance was set at 5% level.

3. Results

A total of 120 participants were sampled for this study that included 73 males and 47 females. Mean age of the participants was 23.5 years (minimum 21 years and maximum 38 years). Mean ICD was 128.07 mm (minimum 104.20 mm and maximum 145.25 mm), mean inter-canine distance, MIC was 35.25 mm (26.26 mm and maximum 41.91 mm) and the mean inter-molar distance, MIM was 50.13 mm (minimum 40.82 mm and maximum

Table 1. Descriptive statistics of age, inter-molar, inter-canine, inter-condylar distances (n=120)

	Minimum	Maximum	Mean	Std. Deviation
Age	21	38	23.51	4.110
Inter-molar distance	40.82	60.23	50.1354	4.74307
Inter-canine distance	26.26	41.91	35.2534	2.93662
Inter-condylar distance	104.20	145.25	128.0694	7.29476

Table 2. Correlation between inter-molar, inter-canine, inter-condylar distances

		Inter-molar distance	Inter-canine distance	inter-condylar distance
Inter-molar distance	Pearson Correlation	1	.250**	.589**
	Sig. (2-tailed)		.006	.000
	N	120	120	120
Inter-canine distance	Pearson Correlation	.250**	1	.330**
	Sig. (2-tailed)	.006		.000
	N	120	120	120
Inter-condylar distance	Pearson Correlation	.589**	.330**	1
	Sig. (2-tailed)	.000	.000	
	N	120	120	120

60.23 mm) (Table 1). While looking at the Pearson correlation of those parameters, both the MIM and the MIC were found to show significant correlation ($p<0.001$) with ICD. However, the MIC showed statistically non-significant correlation ($p=0.006$) with the MIM (Table 2).

Table 3 shows the group statistics showing the mean values of all those parameters amongst males and females. Mean inter-molar distance was 50.98 mm (SD – 4.60) in the male population and 48.81 mm (SD – 4.70) in the female one. Males had the mean inter-canine distance of 35.67 mm (SD – 3.15) and females had it of 34.60 (SD – 2.45). Inter-condylar distance in the males had the mean value of 130.47 mm (SD – 6.65) and that in females had the mean value of 124.33 mm (SD – 6.69). When analysed with Independent t-test according to the gender, the difference in the mean values of inter-canine distance was not statistically significant, however the inter-condylar distances ($t=4.914$, $p<0.001$) and inter-molar distances ($t=2.498$, $p=0.015$) between male and female showed statistically significant difference (Table 3).

Table 4 shows the group statistics showing the mean values of inter-condylar, inter-canine and inter-molar distance between the sample population with age of more than 25 years and less than 25 years. Among the population younger than 25 years of age, the mean value of inter-molar distance was 49.31 mm (SD – 4.46), that of inter-canine distance was 35.03 mm (SD – 2.74) and that of inter-condylar distance was 126.99 mm (SD – 6.92). Similarly, among the population of age 25 years or more, the mean inter-molar distance was 52.04 mm (SD – 4.87), mean inter-canine distance was 35.76 mm (SD – 3.33) and the mean inter-condylar distance was 130.56 mm (SD – 7.61). Their independent t-test analysis showed statistically significant difference in the inter-molar distance ($t=-2.99$, $p=0.003$) and the inter-condylar distances ($t=-2.51$, $p=0.013$) between those of less than 25 years old with those of 25 years or more. The difference between the inter-canine distances was, however, statistically not significant (Table 4).

4. Discussion

Selection and arrangement of the artificial teeth becomes the most indispensable act in complete denture fabrication. The guiding principles for selection of those teeth are esthetics (more for anterior than for posterior

Table 3. Correlation of inter-molar, inter-canine, inter-condylar distances with gender

Variables	Sex	N	Mean	Std. Deviation	Std. Error Mean	t value	P value
Inter-molar distance	M	73	50.9849	4.60382	0.53884	2.498	0.015
	F	47	48.816	4.70095	0.6857		
Inter-canine distance	M	73	35.6708	3.15615	0.3694	1.964	0.052
	F	47	34.6051	2.45187	0.35764		
Inter-condylar distance	M	73	130.4719	6.65831	0.7793	4.914	<0.001
	F	47	124.3379	6.69948	0.97722		

Table 4. Correlation of inter-molar, inter-canine, inter-condylar distances with age group

Variables	Age group	N	Mean	Std. Deviation	Std. Error Mean	t value	P value
Inter-molar distance	<25	84	49.316	4.46844	0.48755	-2.99	0.003
	>=25	36	52.0475	4.8751	0.81252		
Inter-canine distance	<25	84	35.0351	2.74162	0.29914	-1.25	0.215
	>=25	36	35.7628	3.33386	0.55564		
Inter-condylar distance	<25	84	126.999	6.92804	0.75591	-2.51	0.013
	>=25	36	130.5669	7.61164	1.26861		

teeth), whereas mastication and phonetics play a determining role during arrangement. Arrangement of artificial teeth in a complete denture is determined by their position in relation to facial anatomic landmarks and it is said that these teeth should be positioned as closely as to their natural predecessors in the respective jaws to rehabilitate an edentulous patient with prosthetic teeth that approximates both in size and position of the lost natural teeth. An absence of pre-extraction records, however, is a major deterrent to practicing this philosophy of complete denture fabrication. In such situations, various stable anatomical landmarks and their correlations are used for the same purpose. This study evaluated the three commonly used parameters MIC, MIM and ICD and their correlation in the 120 dentate subjects (73 males and 47 females) so that those relations could be incorporated for arrangement of teeth in a completely edentulous mouth. The mean age of the sample was 23.5 years (maximum-38 years, minimum-21 years). Subjects younger than 20 years of age were not selected for the study as the inter-canine distance and inter-molar distances of both arches increase significantly for the period over 8 years to 20 years of age, suggested by Rai, et al[8]. The method to locate the condylar position, to measure Inter-Condylar Distance (ICD), Maxillary Inter-canine Distance (MIC) and Maxillary Inter-Molar distance (MIM) as well as to prepare the stone casts were similar as described by Keshvad, et al.[2] and Shaikh, et al[9].

This study found the mean ICD of the total sample population to be 128.06 mm that was nearly identical as reported by Dahri, et al.[10] but higher than reported by Keshvad. et al.[2], Shaikh, et al[9]. The ratio of ICD to MIC was 3.6:1 and that of ICD to MIM was 2.6:1. Hence position of maxillary canine tips should be placed at the distance of ICD divided by 3.6 and the position of mesiobuccal cusps of maxillary first molars should be arranged at the distance of ICD divided by 2.6.

Strong positive correlation of ICD was found with MIC (r- 0.33, p-0.0001) and MIM (r- 0.59, p-0.0001) similar to the findings of the studies by Keshvad, et al.; Dahri, et al. and Shaikh, et al. All of the distances i.e. ICD, MIC and MIM were larger in males as compared to females, this might be due to the anthropometric difference in head and jaw sizes, males having larger as compared to females. The difference was statistically significant for ICD (p-0.0001) and the MIM (p=0.015) whereas were not statistically significant for MIC. Similarly, all the distances were larger for the population with equal or more than 25 years old as compared to the younger population. The difference was however statistically significant for MIM only (p-0.003), other differences being non-significant. These findings might suggest that growth of head and jaws might continue even after 25 years though not significantly.

5. Conclusion

Within the limitation of relatively small sample size and ethnically diverse sample population, the following conclusions can be drawn.

Intercondylar distance has strong and positive correlation with the maxillary inter-canine and inter-molar distances. The ratio can be calculated to position the artificial denture teeth once we know the inter-condylar distance. Females have relatively smaller head and jaw sizes compared to the males and hence all the distances have smaller values. Similarly, the intercondylar, inter-canine and inter-molar distances are lesser in younger population as compared to the elder ones.

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