ORIGINAL RESEARCH

Mandibular Intercanine Width at Three Stages of Mixed Dentition in Children at Namakkal District: A Cross-sectional Study

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Abstract

Aim: To assess and compare the mandibular intercanine width (ICW) of children at three stages of mixed dentition in children at Namakkal district.

Materials and methods: An analytical cross-sectional study was conducted among 135 schoolchildren aged 7–11 years, with 45 children in each group. Group I included children with completely erupted permanent mandibular central incisors, group II included children with completely erupted permanent mandibular central and lateral incisors, and group III included children with completely erupted permanent mandibular central incisors, lateral incisors, and canines. Impressions were made in the mandibular anterior region, and study casts were prepared. Measurements of the mandibular ICW were taken using a digital vernier caliper.

Results: The mean mandibular ICW after the complete eruption of permanent mandibular central incisors, lateral incisors, and canines was 23.7, 25.5, and 25.7 mm, respectively. There was a statistically significant difference in the ICW between the three groups ($p < 0.001$). *Post hoc* tests showed that mandibular ICW was statistically significant between groups I and II and group III ($p < 0.001$). Linear regression analysis showed that age does not contribute to the changes in mandibular ICW.

Conclusion: The average mandibular ICW found can be a standard comparison for treatment planning in the western Tamil Nadu population. Mandibular ICW reaches its maximum after the eruption of permanent mandibular lateral incisors. Changes in mandibular ICW should be attributed to the eruption of permanent mandibular anterior teeth and not to the age of the child.

Keywords: Canine teeth, Cross-sectional study, Incisors, Mandible, Mixed dentition, Tooth eruption.

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Introduction

The knowledge of mandibular intercanine width (ICW) is of paramount interest during an interception in mixed dentition. Mandibular ICW is the linear distance between the cusps of contralateral canines. In case of cuspal wear, the distance between the center of the worn surfaces is considered.[1] The dental arch dimensions systematically change during the period of intensive growth and development, but lessen in adulthood.[2] Mixed dentition is the period when the mandibular ICW reaches its maximum.[3] During the mixed dentition stage, the changes that occur in the dental arches are the consequences of tooth eruption and growth of supporting bones, besides a modest genetic component.[3] The two most common clinical considerations of the mandibular ICW are, firstly, the high prevalence of permanent mandibular incisor crowding, which is about 29% in southern India.[4] The second is posttreatment retention of mandibular ICW.[5]

The crowding of mandibular incisors is managed in the mixed dentition by either proximal stripping or timely extraction after mixed dentition model analysis.[6] This management varies in the permanent dentition by either expanding the mandible or extracting premolars after model analysis.[6,7] However, both management approaches have their own disadvantages and controversies. Timely extractions have the disadvantage of decreasing arch circumference. Lack of follow-up during canine eruption can lead to ectopic eruption of the canine or impaction of the mandibular canine, which further complicates future orthodontic treatment.[8,9] The therapeutic increase in the ICW during orthodontic treatment has a higher tendency for relapse unless accompanied by maxillary expansion.[9] Thus, precise knowledge about the changes in mandibular ICW as teeth erupt helps clinicians make better treatment plans.

Hence, the present study aimed to estimate and compare mandibular ICW changes after each mandibular anterior teeth eruption in children at Namakkal district, with three different eruption statuses of mandibular anterior teeth. The objective of the study was to estimate the mandibular ICW after the complete eruption of the following permanent mandibular teeth—(1) central incisors, (2) lateral incisors, and (3) canines.

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Materials and Methods

An analytical cross-sectional study design was planned. The study protocol was approved by the Institutional Review Board and the Institutional Ethics Committee of our institution. The study was conducted between July and August 2023 in government schools of Namakkal district, Tamil Nadu, after obtaining prior permission from school authorities. The participants included in the study were of South Indian origin. Verbal assent from the participants and written informed consent from their parents were obtained.

A pilot trial was conducted with 15 children divided equally into three groups ($n = 5$). The study population was divided based on the teeth present in their mandibular anterior region as follows—group I—children with completely erupted permanent mandibular central incisors and primary mandibular lateral incisors (either present or exfoliated); group II—children with completely erupted permanent mandibular central and lateral incisors and primary canines (must be present); and group III—children with completely erupted permanent mandibular central incisors, lateral incisors, and canines. Teeth were marked as completely erupted when the full clinical crown was visible or when the tooth reached its functional position in the oral cavity. Children with partially erupted permanent lower anterior teeth were excluded.

Based on the results of the pilot trial, the sample size was estimated as 135 children using F-test analysis of variance (ANOVA) (effect size: 0.35; power: 0.95), with 45 in each group. Children aged 7–11 years who had intact dentition without any grossly decayed or multisurface carious teeth were included in this study. Those who had significant attrition, hypoplastic teeth, impacted teeth, congenital craniofacial or dental anomalies, a history of orthodontic treatment, or any oral deleterious habits were excluded.

A total of 1,400 children were screened for the study. A cluster sampling method was employed, with the clusters including 2–7th standard schoolchildren from eight schools in Namakkal District. A total of 135 children were selected for the study based on the inclusion and exclusion criteria (Fig. 1). Demographic details were collected. Condensation silicone (Orikam Neoendo Neopure C-Silicone impression material kit, Medikabazaar, India) impressions were made for all children using mandibular anterior sectional trays in their respective classrooms. Impressions were disinfected with two percent glutaraldehyde for 10 minutes.[10] Study models were made with type III dental stone (Shruti Gem Stone Plaster—Green, Dhanraj Dental Suppliers, Ajmer).[11]

Mandibular ICW was measured between the right and left canine cusp tips,[12] and in cases of canine wear, the distance between the centers of worn-out surfaces was measured.[1] This was done using a digital vernier caliper (SAFESEED® Electronic Digital Vernier Caliper Ruler Carbon Fiber Composite 6-inch 150 mm). The study models were measured at 30-minute intervals for every 20 dental casts. Two independent observers measured the mandibular ICW. Interobserver reliability was checked and found to be excellent (κ-value = 0.9). Confounding factors such as dental arch form and molar relation were recorded during the oral examination (ADA type III) at school. Child's height and weight were measured using a stadiometer and digital weighing machine, respectively. Body mass index (BMI) was calculated using Lambert Adolphe's formula, and interpretation was done using the Centers for Disease Control and Prevention criteria.

Univariate analysis was made for qualitative data and expressed as frequency and percentage. Bivariate analysis comparing the ICW between the three groups was done using ANOVA followed by *post hoc* analysis. A multiple linear regression was carried out to identify the predictors of ICW after adjustment for the influence of other variables. The variables included in the model were age, gender, groups, molar relation in permanent and deciduous dentition, and BMI. The p-values < 0.05 were considered statistically significant. All analyses were carried out in Statistical Package for the Social Sciences (version 23; IBM, Chicago).

Results

Demographic details of the study participants in each group are shown in Table 1. The other parameters recorded, such as arch form, molar relation, and BMI, are shown in Table 2. The mean mandibular ICW after the eruption of permanent mandibular central incisors, lateral incisors, and canines were 23.7, 25.5, and 25.7 mm, respectively (Table 3). There was a statistically significant difference ($p < 0.001$) in the mandibular ICW between the three groups. *Post hoc* analysis showed statistical significance ($p < 0.001$) between group I and group II and group I and group III ($p < 0.001$). There was no significant difference between group II and group III ($p = 0.894$) (Table 4). There was a statistically significant difference noted between age-groups

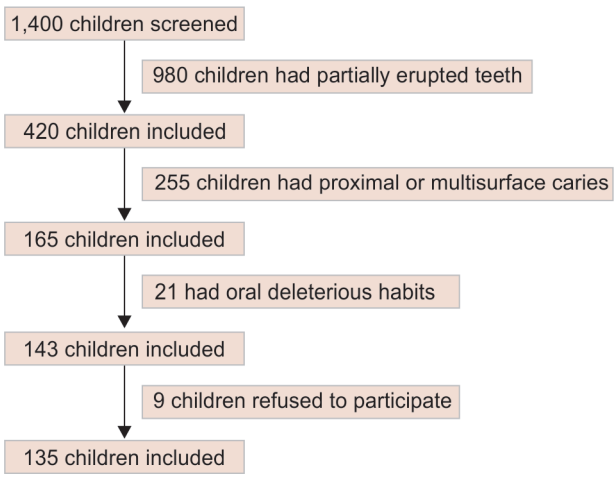

Fig. 1: Flowchart for sampling method

Table 1: Demographic detail of the study population

Characteristics		*Total (n = 135) frequency (%)*	*Group I (n = 45) frequency (%)*	*Group II (n = 45) frequency (%)*	*Group III (n = 45) frequency (%)*
Sex	Female	81 (60)	29 (64.4)	18 (40)	34 (74.5)
	Male	54 (40)	16 (35.6)	27 (60)	11 (25.6)
Age (years)	7	15 (11.1)	15 (33.3)	–	–
	8	30 (22.2)	27 (60)	3 (6)	–
	9	19 (14.1)	3 (6)	15 (33.3)	1 (2.2)
	10	22 (16.3)	–	15 (33.3)	7 (15.5)
	11	49 (36.3)	–	12 (26.6)	37 (82.2)

seven and nine ($p = 0.02$), 10 ($p = 0.002$), and 11 ($p = 0.001$) and between eight and 10 ($p = 0.004$), 11 ($p = 0.002$) (Table 5). Multiple linear regression with ICW as the dependent variable showed that the model was significant with an R2 value of 0.26. Variables, including groups, gender, and type of occlusion in deciduous and permanent dentition, were found to be significant predictors of ICW. However, the ability of the latter three variables to predict ICW at the population level may be questionable, as reflected by the confidence intervals of the beta coefficients (Table 6).

Discussion

Dental arch dimensions and ICW changes have been discussed with both the dental and chronological age of children.[13–15] Hence, the present study was carried out to assess the changes in the mandibular ICW during the eruption of permanent mandibular anterior teeth. Changes in mandibular ICW based on dental age have shown variable results.[14,15]

The results of the current study demonstrated that maximum mandibular ICW increased following the eruption of the permanent lateral incisors. The values did not significantly increase between the eruption of the permanent mandibular lateral incisors and the permanent mandibular canines. Moorrees and Reed showed

Table 5: Intergroup comparison of mandibular intercanine width (based on age)

Age (years)	*Mean (mm)*	*Comparison age (years)*	*Mean difference*	*p-value*
7	23.49	8	−0.47	0.92
		9	−1.98	0.020*
		10	−2.34	0.002*
		11	−2.12	0.001*
8	23.96	9	−1.51	0.05
		10	−1.87	0.004*
		11	−1.65	0.002*
9	25.47	10	−0.36	0.97
		11	−0.14	0.99
10	25.83	11	0.21	0.99
11	25.61	–	–	–

*p-value < 0.05 were considered statistically significant

Table 2: Frequency distribution based on arch form, molar relation, and BMI

				Groups N (%)		
Characteristics			*Total frequency (%) (n = 135)*	*I (n = 45)*	*II (n = 45)*	*III (n = 45)*
Arch form		Oval	91 (67.4)	36 (80)	27 (60)	28 (62.2)
		Square	29 (21.5)	5 (11.1)	14 (31.1)	10 (22.2)
		Tapered	15 (11.1)	4 (8)	4 (8)	7 (15.5)
Molar relation	Primary teeth	Nil	33 (25.9)	1 (2.2)	1 (2.2)	31 (68.8)
		Mesial step	63 (46.7)	29 (64.4)	26 (57.7)	8 (17.7)
		Flush terminal plane	26 (19.3)	9 (20)	11 (24.4)	6 (13.3)
		Distal step	13 (9.6)	6 (13.3)	7 (15.5)	–
	Permanent teeth	Nil	4 (5.1)	4 (8.8)	–	–
		Class I	72 (53.3)	25 (55.5)	22 (48.8)	25 (55.5)
		End on	54 (40)	14 (31.1)	22 (48.8)	18 (40)
		Class II	5 (3.7)	2 (4.4)	1 (2.2)	2 (4.4)
BMI (percentile range)		Underweight (<5%)	28 (20.7)	13 (28.8)	9 (20)	6 (13.3)
		Healthy (5–85%)	88 (65.2)	28 (62.2)	35 (77.7)	25 (55.5)
		Risk of overweight (85–95%)	11 (8.1)	3 (6.6)	1 (2.2)	7 (15.5)
		Overweight (>95%)	8 (5.9)	1 (2.2)	–	7 (15.5)

Table 3: Intergroup comparison of mandibular intercanine width among three groups

			95% confidence interval		
Groups	*n = 135*	*Mean ± SD (mm)*	*Lower bound*	*Upper bound*	*p-value*
I	45	23.77 ± 2.05	23.15	24.40	<0.001*
II	45	25.58 ± 1.75	25.05	26.11	
III	45	25.76 ± 1.63	25.27	26.25	

*p-value < 0.05 were considered statistically significant

Table 4: *Post hoc* analysis of intergroup comparison of mandibular intercanine width

					95% confidence interval	
Groups	*Comparison group*	*Mean difference*	*Standard error*	*p-value*	*Lower bound*	*Upper bound*
I	II	−1.81	0.38	<0.001*	−2.72	−0.89
	III	−1.98	0.38	<0.001*	−2.89	−1.07
II	I	1.80	0.38	<0.001*	0.90	2.72
	III	−0.17	0.38	0.894	−1.08	0.73
III	I	1.98	0.38	<0.001*	1.07	2.89
	II	0.17	0.38	0.894	−0.73	1.08

*p-value < 0.05 were considered statistically significant

Table 6: Linear regression analysis

	Unstandardized coefficients			*95% confidence interval for B*	
Variables	*Beta*	*Standard error*	*p-value*	*Lower bound*	*Upper bound*
(Constant)	26.05	1.79	0.00	2.50	29.59
Age	−0.03	0.21	0.90	0.45	0.39
Groups	1.22	0.39	0.002*	0.45	2.00
BMI	0.04	0.05	0.44	−0.06	0.13
Primary occlusion	−0.51	0.20	0.013*	0.90	−0.11
Permanent occlusion	−0.76	0.29	0.010*	1.33	− 0.19
Gender	−0.94	0.33	0.006*	1.60	−0.28

*p-value < 0.05 were considered statistically significant

that the average mandibular ICW following the eruption of the permanent mandibular central incisors, lateral incisors, and canines was 24.35, 25.45, and 25.3 mm, respectively.[16] These results were almost similar to the current study, with the exception of a slight decrease shown following the eruption of the canine. Bishara et al. concluded that mandibular ICW was established after the eruption of permanent mandibular incisors.[17]

In the present study, there was a statistically significant difference in the mandibular ICW between the different age-groups. However, linear regression analysis showed that age does not play a statistically significant role in changing the mandibular ICW. Hence, the changes can be better explained based on the dental age of the child rather than the chronological age. The current study emphasizes that the eruptive state of the mandibular anterior teeth should be considered important when determining the changes in mandibular ICW. However, Bishara et al. claimed that the ICW increased quickly from five to 8 or 9 years of age.[17]

Mandibular ICW has been shown to be different in different ethnic backgrounds.[18–20] Ross-Powell and Harris and Arslan et al. in Black American and Turkish populations found that the average mandibular ICW at 11 years was 28.4 and 21.2 mm, respectively, whereas it was 25.6 mm in the present study population.[18,19] Understanding these differences in varied cultural and ethnic backgrounds becomes important during the decision-making process for treating lower anterior crowding in the mixed dentition period.

In order to rule out the influence of confounding variables, gender, age, arch form, and molar relation were included.[21,22] Sillman and Moyers et al. found differences in mandibular ICW between genders; however, the magnitude of the difference varied depending on the population.[23,24]

In the present study, there was uneven gender distribution among the groups, which could be a possible limitation. The study included children aged 7–11 years, but the groups were divided based on the eruption of the mandibular anteriors. Girls, being early maturers, were more represented in group III at 11 years, where permanent mandibular canines were completely erupted, whereas boys had only partially erupted permanent mandibular canines at that age. Group II, on the other hand, had a higher proportion of boys. Further research could be conducted with a larger sample size and with an equal proportion of boys and girls in all groups. This study is being continued as an ongoing longitudinal study to evaluate changes in mandibular ICW periodically in the same population.

Conclusion

Mandibular ICW significantly increased after the eruption of the permanent mandibular lateral incisors. There was no significant increase in mandibular ICW during the eruption of permanent mandibular canines. The change in mandibular ICW should be attributed to the eruption of the permanent mandibular anterior teeth rather than the age of the child.

Clinical Significance

The average mandibular ICW found can serve as a standard comparison for treatment planning in the western Tamil Nadu population. The finding that mandibular ICW reaches its maximum after the eruption of permanent mandibular lateral incisors should be taken into consideration during interceptive orthodontics for mandibular incisor crowding management. Since there is no apparent increase in mandibular ICW during the eruption of permanent mandibular canines, it is important to judiciously extract lower primary canines while treating crowded lower anterior teeth.

Institutional Review Board Approval

The study was approved by the Institutional Review Board and Institutional Ethics Committee (Ref: IEC-PG/MAR/2023/097).

Author Contributions

- Chandrakantha Balaraman: Conceptualization, investigation, and writing—review and editing.
- Sharath Asokan: Conceptualization, supervision, and writing—review and editing.
- Geetha P Pollachi-Ramakrishnan: Conceptualization, supervision, and writing—review and editing.
- Yogesh K Thoppe Dhamodharan: Writing original draft and review—editing.
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