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RESEARCH ARTICLE

DETERMINATION OF NORMAL MAXILLARY TRANSVERSE DIMENSION BY USING INTERCANINE AND INTER FIRST PERMANENT MOLAR WIDTH

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ABSTRACT

Background: While vertical and sagittal malocclusions are relatively straightforward to detect, diagnosing issues in the transverse dimension poses a challenge. Currently, there are no established criteria to define what constitutes a normal transverse occlusion. **Objective:** The aim of this study was to determine a value that defines a normal transverse occlusion and to identify cases which require arch expansion as a part of the treatment plan. Study Design: A in vitro retrospective study design was employed. **Materials and Methods:** The study included 150 maxillary dental casts from individuals aged 12 to 22 years. Among these, 75 belonged to a control group, and 75 to a study group. The casts were randomized and assessed by a single operator, who measured the intercanine width (ICW) and inter molar width (IMW). The data were statistically analyzed using SPSS software version 25.0. Unpaired t-test & Mann whitney U test were performed to test the statistical significance difference between the groups at $p \leq 0.05$. **Results:** According to our study, the values of intercanine width determining normal and deficient arches are 36.90±2.66 and 33.29±2.42 mm, respectively. Similarly, the value of intermolar width for normal arches is 41.53±2.1mm and 39.12 ±2.8mm for deficient arches. **Discussion & Conclusions:** ICW and IMW measurements are reliable indicators for assessing maxillary transverse dimensions. This simple, non-invasive method can aid in early diagnosis and treatment planning for maxillary arch expansion in clinical orthodontic practice.

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INTRODUCTION

Dental arch size and form have a significant impact on orthodontic diagnosis, treatment planning, aesthetics, tooth stability, and available space. Dental crowding, which is caused by an imbalance between aggregate tooth size and accessible arch perimeter, is the most common type of malocclusion seen in normal orthodontic practice[1]. Primarily, the most prevalent skeletal issues in the craniofacial region are maxillary arch constriction brought on by an arch width shortage. Researchers have examined the increase in arch width in those with normal occlusion compared to that of people with various malocclusions. However, because there was disagreement among the orthodontists over a specific set of criteria, the diagnosis resulted in a number of discussions and disputes[1, 2] The measurement of anterior arch width using intercanine distance and posterior arch width using inter first permanent molar distance yields the maxilla's transverse dimension. The transverse dimension has also been evaluated in several investigations using the interpremolar distance.

Broad-arched maxillae have demonstrated steady, balanced, and typical occlusion. Therefore, it is imperative that normal and broad arches should be depicted from narrow and inadequate arch widths[1].The McNamara hypothesis, Pont's formula, Schwartz's analysis, Korkhause analysis, finger palpation technique, Rickett's method employing cephalometric analysis, Howe's index, and Moyer's index are some of the techniques that different writers have suggested to assess transverse dimensions.

But each of these approaches has drawbacks of its own.[3] In order to quantify the width of the maxillary arches and determine a value that would distinguish between normal and narrow maxillary arches, we have used the intercanine width (ICW) and intermolar width (IMW) as the parameters in this study. The other objectives of this study were to provide a point of reference for achieving a proportionate arch width after treatment and to identify cases requiring maxillary expansion.

Following landmarks were measured on 150 study models with an electronic digital caliper (Table 1):

SL. NO	LANDMARKS	DESCRIPTION
1.	INTERCANINE WIDTH (ICW) (Fig 1)	The ICW will be measured from tips of right to left canines. In case where the canines are out of the arch will take the centre of the alveolar arch in canine region.
2.	INTERMOLAR WIDTH (IMW) (Fig 1)	The IMW will be measured from the mesiolingual cusp tip of the first right and left molars for this study
3.	SUM OF INCISORS(SI) (Fig 1)	The mesiodistal widths of all the four upper incisors were calculated and summed up.

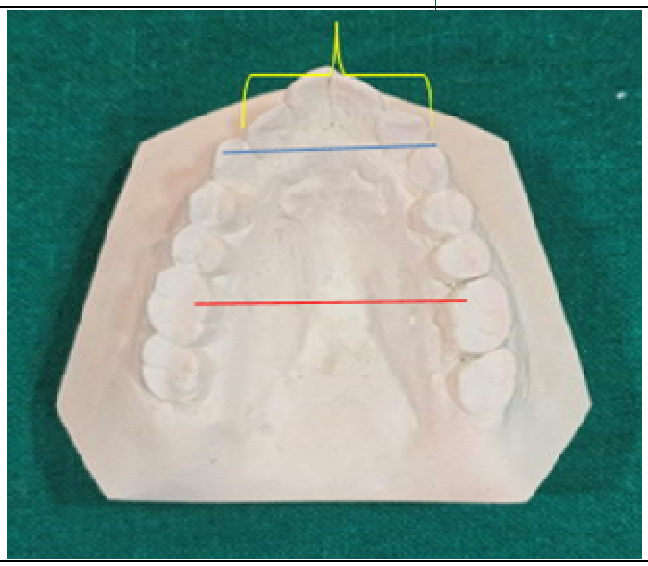


Fig.1. RepresentingICW,IMW ,SI on study model

Fig.2. Digital Caliper

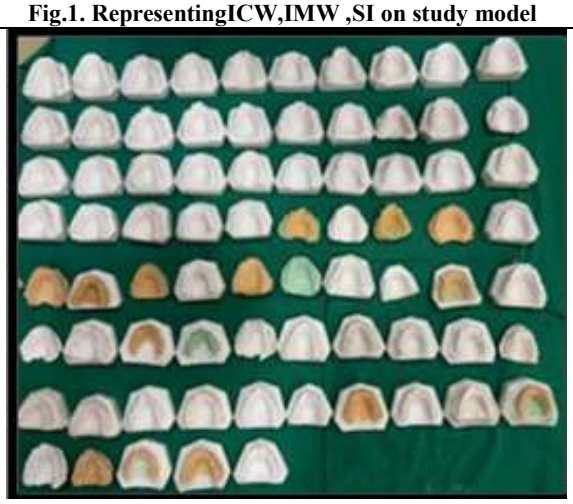
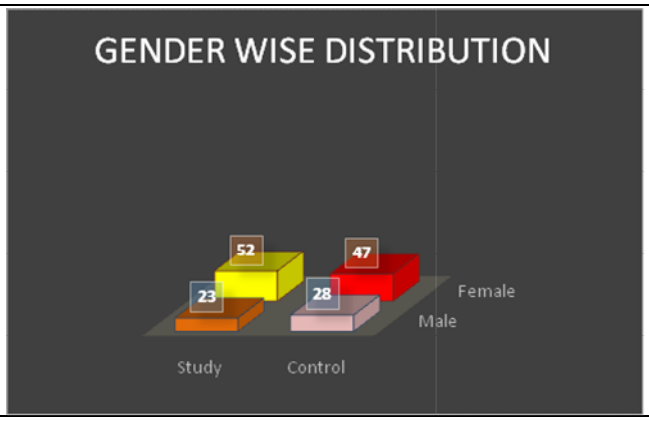
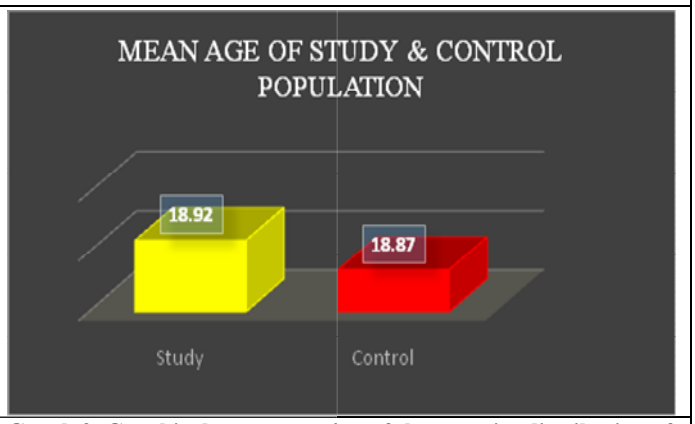


Fig. 3. Photographs of models of the study group (75nos)

Fig. 4. Photographs of models of the study group (75nos)



Graph 1. Graphical representation of the Gender wise distribution of study and control group



Graph 2. Graphical representation of the age wise distribution of study and control group

MATERIAL AND METHODS

The study is an in-vitro retrospective study conducted on the patients presenting to the OPD of Hi-Tech Dental College and Hospital during 2 years of tenure. The study was done on the models of 150 individuals (75 in the study group & 75 in the control group)(fig3&4) presenting to the hospital OPD. The age group for the study was 12-22 years with a mean age of 17±2 years.

Ethical Consideration: Ethical clearance was obtained from the ethical committee of the institutional review board.

Inclusion criteria

CONTROL GROUP

- Well aligned and normal arches not requiring orthodontic treatment.
- No crowding, spacing or severe attrition present.
- No clinically evident interproximal carries.
- No previous history of orthodontic and prosthodontic treatment.
- Presence of the permanent maxillary tooth from left 1st molar to right 1st molar.

STUDY GROUP

- Maxillary arches with dental discrepancies including arch width deficiency, v shaped palate with deep palatal vault, unilateral or bilateral crossbite or crowding requiring or seeking orthodontic treatment.
- Presence of permanent maxillary canine and first molar.
- Patients advised for maxillary expansion as a part of their comprehensive treatment plan.

Exclusion criteria

- Absence of permanent maxillary canine and first molar.
- Any developmental anomalies
- Had cleft lip or palate or any craniofacial syndromes.

After obtaining the linear measurements, we compared our values with the Banker's hypothesis, the korkhause analysis and the McNamara criteria. Then, the ratio between IMW and ICW are calculated (IMW:ICW) to compare it with the Banker's hypothesis which suggested that if ratio between IMW: ICW = 1:1 ± 0.5, it is a normal arch and if the ratio increases it is designated as deficient arch.

The comparision is made with the Korkhause analysis by calculating the CMV i.e CMW = SI X 100/64. It suggests that if the MMV is less than the CMV it is a deficient arch & if MMV> CMV then it is a normal arch. We also have taken into consideration the McNamara analysis which suggests maxillary arches with IMW ≤31 mm = deficient arches, maxillary arches with IMW ≥36 mm = normal arches.

STATISTICAL ANALYSIS

Ms Excel 2016 was used to fabricate the datasheet.IBM SPSS Corp. in Armonk, New York for Windows, Version 25.0, was used for the statistical analysis.

Descriptive statistics were presented in the form of Mean and Standard Deviation (SD) & Standard Error (SE). Unpaired t test & Mann whitney U test statistics were applied to calculate the inferential statistics of the different variables between the different groups. The statistical Significance was fixed at $p<0.05$. The distribution of the study sample was normally distributed. Graphically the results were represented as bar graphs and tabular charts.

RESULTS

According to this study the results showed there is statistically significant difference present between the study & the control group in all the parameters except for the age which showed no statistical difference as the age range is between 12 to 22 years with a mean age of 18.92 ±3.2years (Table 2,4)),(Graph 2).According to our study the value of intercanine width determining normal and deficient arches are 36.90±2.66mm and 33.29±2.42mm respectively. Similarly the value of intermolar width is for normal arches is 41.53±2.1mm and 39.12 ±2.8mm for deficient arches. The value of sum of incisors for normal and deficient arches as per our study in the control and study group are 29.63± 2.7mm and 32.9 ±2.3mm respectively.(Table 2),(Graph 3) By using Banker's hypothesis we also have concluded that the proportionate value of IMW/ICW is 1.1 ± 0.09 suggestive of normal arch width and 1.1±0.1 for the deficient arch width(Graph 5). As per the Korkhause analysis in our study the values that differentiate between the normal and deficient arch width are 46.74 ±4.4mm and 50.9 ±4.5mm respectively (Table 2),(Graph 4). Based on the McNamara criteria it determined more of the normal arches than the deficient ones (Table 3,5).

Table 2. Descriptive distribution of study population

Variables	Mean	Std. Deviation	Std. Error Mean
Age	18.92	3.233	.373
Inter Canine Width	33.2933	2.42606	.28014
Inter Molar Width	39.1200	2.82824	.32658
Sum Of Incisors	32.9267	2.36485	.27307
Bankers Hypothesis	1.1799	.12797	.01478
Korkhause Analysis	50.9779	4.54906	.52528

Table 3. Frequency distribution of Study Population

Variables	Mean	Frequency	%
Gender	Male	23	30.7
	Female	52	69.3
McNamara Analysis	Normal	66	88
	Deficient	09	12

Table 4. Descriptive distribution of Control population

Variables	Mean	Std. Deviation	Std. Error Mean
Age	18.87	3.342	.386
Inter Canine Width	36.9000	2.66484	.30771
Inter Molar Width	41.5333	2.17065	.25064
Sum Of Incisors	29.6333	2.73161	.31542
Bankers Hypothesis	1.1309	.09643	.01114
Korkhause Analysis	46.7477	4.44719	.51352

Table 5. Frequency distribution of Control Population

Variables	Mean	Frequency	%
Gender	Male	28	37.3
	Female	47	62.7
McNamara Analysis	Normal	75	100
	Deficient	00	00

Table 6. Gender wise comparison of variables for study population

Variable	Gender	Number	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
Inter Canine Width	Male	23	32.7391	2.24048	.46717	-1.322	73	.190
	Female	52	33.5385	2.48495	.34460			
Inter Molar Width	Male	23	39.3043	3.12519	.65165	.373	73	.710
	Female	52	39.0385	2.71497	.37650			
Sum Of Incisors	Male	23	32.7391	2.58435	.53887	-.454	73	.651
	Female	52	33.0096	2.28269	.31655			
Bankers Hypothesis	Male	23	1.1778	.12003	.02503	-.096	73	.924
	Female	52	1.1809	.13245	.01837			
Korkhause Analysis	Male	23	51.6330	4.46159	.93031	.828	73	.411
	Female	52	50.6881	4.60005	.63791			

Table 7. Gender wise comparison of variables for Control population

Variable	Gender	Number	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
Inter Canine Width	Male	28	37.8929	2.46966	.46672	2.584	73	.012
	Female	47	36.3085	2.62420	.38278			
Inter Molar Width	Male	28	41.1786	1.84699	.34905	-1.094	73	.278
	Female	47	41.7447	2.33562	.34069			
Sum Of Incisors	Male	28	30.0536	2.70233	.51069	1.029	73	.307
	Female	47	29.3830	2.74696	.40069			
Bankers Hypothesis	Male	28	1.0905	.07741	.01463	-2.949	73	.004
	Female	47	1.1551	.09925	.01448			
Korkhause Analysis	Male	28	47.4864	4.32239	.81686	1.112	73	.270
	Female	47	46.3077	4.50775	.65752			

Table 8. Comparison of variables between males of study and control groups

Variable	Group	Number	Mean	Std. Deviation	Std. Error Mean	T	df	Significance
Inter Canine Width	Study	23	32.7391	2.24048	.46717	-7.729	49	.000
	Control	28	37.8929	2.46966	.46672			
Inter Molar Width	Study	23	39.3043	3.12519	.65165	-2.661	49	.011
	Control	28	41.1786	1.84699	.34905			
Sum Of Incisors	Study	23	32.7391	2.58435	.53887	3.601	49	.001
	Control	28	30.0536	2.70233	.51069			
Bankers Hypothesis	Study	23	1.1778	.12003	.02503	3.140	49	.003
	Control	28	1.0905	.07741	.01463			
Korkhause Analysis	Study	23	51.6330	4.46159	.93031	3.360	49	.002
	Control	28	47.4864	4.32239	.81686			

Table 9: Comparison of variables between females of study and control groups

Variable	Group	Number	Mean	Std. Deviation	Std. Error Mean	t	df	Significance
Inter Canine Width	Study	52	33.5385	2.48495	.34460	-5.393	97	.000
	Control	47	36.3085	2.62420	.38278			
Inter Molar Width	Study	52	39.0385	2.71497	.37650	-5.289	97	.000
	Control	47	41.7447	2.33562	.34069			
Sum Of Incisors	Study	52	33.0096	2.28269	.31655	7.169	97	.000
	Control	47	29.3830	2.74696	.40069			
Bankers Hypothesis	Study	52	1.1809	.13245	.01837	1.088	97	.279
	Control	47	1.1551	.09925	.01448			
Korkhause Analysis	Study	52	50.6881	4.60005	.63791	4.777	97	.000
	Control	47	46.3077	4.50775	.65752			

Table 10. Comparison of variables between study and control groups

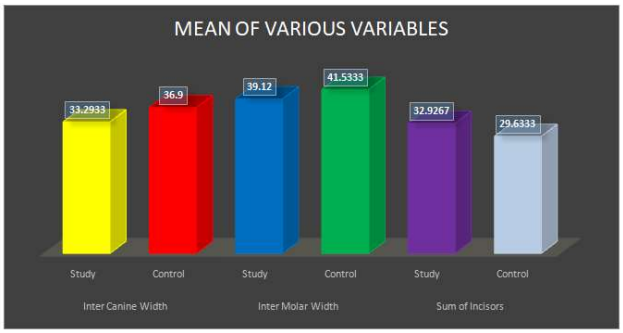
Variable	Group	Number	Mean	Std. Deviation	Std. Error Mean	Significance	95% Confidence Interval	
							Lower	Upper
Age	Study	75	18.92	3.233	.373	.921	-1.008	1.114
	Control	75	18.87	3.342	.386			
Inter Canine Width	Study	75	33.2933	2.42606	.28014	.000	-4.42898	-2.78435
	Control	75	36.9000	2.66484	.30771			
Inter Molar Width	Study	75	39.1200	2.82824	.32658	.000	-3.22685	-1.59982
	Control	75	41.5333	2.17065	.25064			
Sum Of Incisors	Study	75	32.9267	2.36485	.27307	.000	2.46889	4.11777
	Control	75	29.6333	2.73161	.31542			
Bankers Hypothesis	Study	75	1.1799	.12797	.01478	.009	.01243	.08555
	Control	75	1.1309	.09643	.01114			
Korkhause Analysis	Study	75	50.9779	4.54906	.52528	.000	2.77850	5.68177

Table 11. Comparison of McNamara Analysis between study and control groups

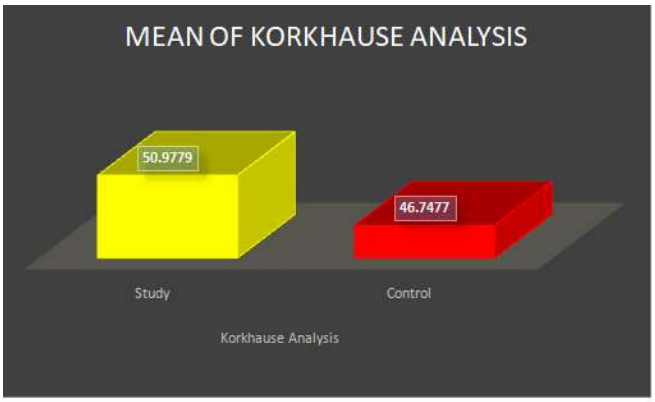
Group	Number	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z	Significance
Study	75	80.00	6000.00	2475.000	5325.000	-3.084	.002
Control	75	71.00	5325.00				

DISCUSSION

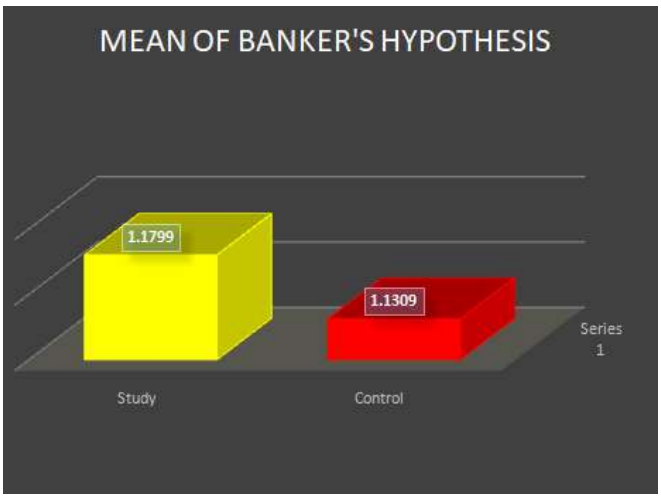
In pretreatment analysis and planning, a comprehensive evaluation of the study models is necessary to determine if the maxillary arch is constricted or expanded at the canine and molar areas. Unplanned management causes post treatment instability in such areas, which can result in recurrence. Molar and canine arch widths did not alter after the ages of 13 and 16, respectively, for female and male individuals, according to researchers who examined growing variations in the transverse



Graph 3. Graphical representation of the various variables distribution in study and control group



Graph 4. Graphical representation of the korkhause analysis of study and control group



Graph 5. Graphical representation of mean of Banker's hypothesis in study and control group

arch width. In a study by Devakrishnan D *et al.* 2021[4] compared the extent of malocclusions like dental crowding and proclination to determine whether arch dimension or tooth size contributes more to these conditions. They came to the conclusion that the mesiodistal tooth dimensions were higher in the crowded and proclination group. The maxilla's intercanine and intermolar widths were also smaller in the crowded group. Having said that, the mesiodistal width of the central and lateral incisors in our study contributes to the sum of incisors; the study group's value, 32.92mm, is greater than the control group's, 29.63mm. Yadav AK *et al.*'s 2024[5] study found that the mandible's mean intercanine arch width was 26.85±1.59 mm, whereas the maxilla's was 35.41±1.47 mm. In the maxilla, the mean intermolar arch width was 53.82±2.82 mm, whereas in the mandible, it was 51.71±2.60 mm. Male and female intercanine and intermolar arch widths in the maxilla and mandible differed statistically significantly. According to our research, the study group's mean intercanine width is 33.29 mm, and mean intermolar width is 39.12 mm. These values are 36.9 and 41.53 mm in the control group, respectively. The study group's male and female members differ from one another in a statistically meaningful way.

According to Staley *et al.*[6], people with Class II division 1 malocclusion had a smaller maxillary dental arch than adults with normal occlusion. In accordance with our study group's inclusion criteria, Angle's class II malocclusion manifested as a proclined maxillary anterior, though it can also show abnormalities like a deep palatal vault, a constricted dental arch, or a crossbite, which narrows the arches and lowers ICW and IMW. Subjects with normal occlusion exhibited wider maxillary canines than those with malocclusion[7]. Sayin and Turkkahraman[8] discovered that while there were no significant differences between the maxillary intercanine width measures, the mandibular inter canine widths were substantially greater in the Class II division 1 group than in the Class I group. As we have analysed the maxillary arch in our study, we have found out similar results . The significance of preserving constant inter-canine width is emphasized by more recent research. They demonstrated how a dental arch's growth produces strong post-retention predispositions for it to return to its pretreatment state. Malocclusion tends to recur, especially when the mandibular arch's canines go farther apart. According to the majority of publications, the kind of therapy has little bearing on the change in intercanine width throughout orthodontic treatment or the post-retention phase. The intercanine distance increases during treatment in both extraction and non-extraction scenarios, although there is a tendency for it to subsequently return to or nearly return to its initial pretreatment dimension. The average mandibular intermolar widths for the males and females were 43.17 mm and 40.5 mm, respectively, while the average maxilla intermolar widths for males and females were 49.36 mm and 46.75 mm, according to Azlan *et al.*'s 2019[9] study on intermolar width in males and females. Our study also revealed that, the average intermolar width in the study population was 39.30 and 39.03mm in males and females respectively, while in the control group it was 41.17 for males and 41.74 for females, indicating a statistically significant difference (Table 6,7). The population diversity in which the indivisual investigations are conducted is the cause.

CONCLUSION

Relapse and retention are, as we all know, two of the most crucial aspects of orthodontic treatment planning. Any

periodontal, bone, muscle, or occlusal dysfunction that results in inadequate retention may necessitate the replacement of the entire orthodontic procedure. One of the many schools of thought about the stability of orthodontic treatment is the apical base school, which was put up by McCauley in 1944 and contends that in order to reduce the likelihood of relapse, both intercanine and inter first permanent molar width should have to be preserved during orthodontic treatment. Because the intercanine and inter first permanent molar widths diminish throughout the post-retention period, the arch's shape and width should have to be preserved throughout orthodontic treatment. According to the study, this pretreatment dental model evaluation method is very simple to use, doesn't involve any costly equipment or additional radiation exposure for the patient, and can be completed at chair side. This allows the clinician to aim for normal intercanine and intermolar width values at the end of the treatment to achieve a proportionate arch.

Limitations: This study, while providing clinically relevant data for diagnosing maxillary transverse discrepancies, has few limitations. First, the sample size was restricted to a single geographic location, which may limit the generalizability of the findings to broader populations. Second, the retrospective in-vitro study design based on dental casts does not account for soft tissue, skeletal relationships, or functional occlusion. Finally, although established analyses were compared, the reliance on linear measurements alone may overlook three-dimensional aspects of maxillary constriction. Future research using cone-beam computed tomography (CBCT) and longitudinal clinical outcomes is recommended for more comprehensive evaluation.

Ethical approval: This study was reviewed and approved by the institutional ethical committee of Hi-tech dental College and hospital, bhubaneswar, odisha. The ethical approval reference number is hmch/iec/2023/014, and the study complied with the declaration of helsinki guidelines.

Conflict of interest: The authors declare no conflict of interest related to this study.

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Glossary of abbreviations

ICW- inter canine width
IMW- inter molar width
SI – sum of incisors

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