Content available at: https://www.ipinnovative.com/open-access-journals

IP Indian Journal of Orthodontics and Dentofacial Research

Journal homepage: https://www.ijodr.com

Original Research Article

Prediction of transverse width changes of dental arches during maxillomandibular sagittal movement using a geometric model

C Priya Dharshini[1], G Sreejith Kumar[2]*, Babukuttan Pillai[3]

[1]Dept. of Orthodontics, Rajas Dental College and Hospital Kavalkinaru, Tamil Nadu, India
[2]Dept. of Orthodontics, Government Dental College Kottayam, Kerala, India
[3]Dept. of Orthodontics, Government Dental College, Thiruvananthapuram, Kerala, India

Abstract

Background: The present study was done to determine the transverse intermolar and intercanine width in normal occlusion and to predict the changes in width at fixed anatomic landmarks on the mandibular arch when the opposing arches were moved in sagittal direction.
Aims & Objectives: To determine the average transverse intermolar and intercanine width in normal occlusion using a digital geometric arch form. To predict the changes in intermolar and intercanine width at fixed anatomic landmarks on the maxillary dental arch when the mandibular arch was moved sagittally at 3 mm, 6 mm, and 9 mm, respectively.
Materials and Methods: 48 subjects between 18 and 30 years with class I occlusion having a pleasing profile were selected, and geometric arch forms of ellipses were obtained on their digital models. The transverse intermolar and intercanine width and the changes were measured by simulating sagittal movement of mandibular arches at 3, 6, and 9 mm, respectively.
Results: The average transverse intermolar width in maxilla and mandible in normal occlusion was 50.51 ± 2.54 mm and 43.44 ± 2.28 mm, and 33.67 ± 2.12 mm and 26.28 ± 2.07 mm, respectively, in the canine region. The mean transverse width changes for molars at 3, 6, and 9 mm were 1.97 ± 0.59 mm and for canines at 3 and 6 mm were 4.03 ± 1.18 mm, which was statistically significant ($p < 0.001$). The relationship of the transverse width at the molar and canine regions and the sagittal movement of dental arches showed that the variables were not significant ($p > 0.05$).
Conclusion: An average intermolar and intercanine transverse width difference exists between maxillary and mandibular arches in normal occlusion. There was an increase in transverse width in the intermolar and intercanine regions when the mandibular arches moved at 3mm, 6mm, and 9mm, respectively, and a predicted ratio can be formulated.

Keywords: Intermolar width, Intercanine width, Transverse arch width changes, Normal occlusion, Geometric archform.

Received: 11-01-2025; **Accepted:** 24-02-2025; **Available Online**: 07-03-2025

1. Introduction

Skeletal malocclusions can occur in all three planes of space and are characterized by dental compensations to mask the severity of the problem, mainly due to the influence of soft tissues. One of the issues usually encountered when treating skeletal malocclusions surgically is difficulty in achieving transverse arch coordination when the dental arches are being moved in the sagittal plane. Conventionally, taking periodic maxillary and mandibular impressions and evaluating the models has been the method followed. Many clinicians find this procedure difficult as it is time-consuming, involves breakage of orthodontic attachments, and involves distorted impressions due to the adhesion of impression material into the bracket-wire assembly. Since the shapes of the dental arches are divergent antero-posteriorly, movement of the whole arch requires modification to the arch width to accommodate the opposing arch. This is most frequently seen in distal movement of the upper arch or forward movement of the lower arch in skeletal class II and vice versa in class III malocclusions.

Several methods have been proposed to evaluate the transverse dimension of dental arches using plaster study models, PA cephalograms, and CBCT images. Traditionally, study models are being used for assessing the transverse

Corresponding author: G Sreejith Kumar
Email: drsreejithkumarg@gmail.com

DOI: 10.18231/j.ijodr.2025.009

relationship of dental arches, and they include Pont's formula, Korkhau's analysis, and the transpalatal width measurement index by Howe et al.[1] McNamara proposed a normal transpalatal arch width of 34 to 36 mm between the lingual grooves of maxillary first molars as ideal for transverse arch coordination.[2] Andrew studied plaster models and suggested that the WALA ridge is the landmark of mandibular arch width and the distance from the FA point to the WALA ridge should be 2 mm.[3] Once the mandibular dentition is decompensated, then the palatal cusps of maxillary molars should be positioned on the central fossae of mandibular molars for optimum transverse arch relationship. Ricketts used frontal analysis for assessing the transverse relationships based on the normal growth measurements on PA cephalograms, and based on this data, Vanarsadall proposed that a maxilla-mandibular difference within 5 mm is considered ideal for transverse relationships.[4] Due to transverse compensations of the dentition, CBCT images are being used now to assess the maxillary and mandibular skeletal widths at different tooth levels, including buccolingual inclination of each tooth and their root positions.[5]

To accurately predict the transverse width changes, geometric forms have been used to describe the shape of the human arch form. Over the years, many geometric arch forms have been constructed to describe the human dental arch form, including catenary curves, parabolas, hyperbolas, ellipses, cubic spline functions, conic sections, polynomial functions including second-order, fourth-order, and sixth-order polynomials, Euclidean distance matrices, Fourier series, beta functions, and the Bezier cubic equation.[6] The ellipse is the best geometric figure for describing the form of both the maxillary and mandibular dental arches when specific landmarks are used for comparisons. As studied previously by Chung and Wolfgramm, by correlating the perimeter of the ellipse to the maxillary arch perimeter using the Ramanujan's equation, it was found out that an ellipse is an accurate geometric model of the maxillary arch form.[7] The correlation of the dental arches to the geometric figure not only permits a static representation but also, by adjusting variables, allows a dynamic representation that aids in the prediction of transverse width changes. The interdependence of the arches has significant implications for arch width changes. Since the shape of the dental arches is divergent antero-posteriorly, movements of a whole arch require modification to the arch width to accommodate the opposing arch. This is most frequently seen in distal movement of the upper arch or forward movement of the lower arch.[8]

There is much diversity among authors in the choice of reference points to evaluate dental arch forms and dimensions, which may include cusp tips, contact points, alveolar bone ridges, mesiodistal widths of anterior teeth, and cranial structures.[9,10,11,12] Bishara et al. in his longitudinal study evaluated the changes in intercanine and intermolar widths over a 45-year span, in which he used the cusp tip of the canine and the mesiobuccal cusp of the molars to measure the arch width.[13] Tancan Uysal, in his study, compared the arch width of class III with normal occlusion and used the cuspal tip for the arch width measurements.[14] Meanwhile, Sayin and Turkkahraman, in their study regarding dental arch and alveolar widths of patients with Class II, Division 1 malocclusion and Class I ideal occlusion, used cuspal tips for the arch width measurements.[15]

Replacement of plaster models with 3D computerized images can benefit the accuracy, efficiency, and ease of measurement of tooth and arch sizes. The two-dimensional image processing techniques, widely used for dental arch form approximation, utilize picture analysis software to convert the (x, y) coordinates of each pixel representing the landmarks of interest into a matrix of numerical data. The curve fitting can be carried out by utilizing a number of mathematical functions. Thus, geometric parameters of dental arches can be assessed using high-precision 3D dental scanners, and the system operation is based on the laser triangulation method.[16] By using geometric models of both maxillary and mandibular arches with normal occlusion, the changes in the transverse width during sagittal displacement of the mandible can be measured at specific landmarks. These data can be used as a reference to identify abnormal variations in intermolar and intercanine width in class II and class III skeletal malocclusions. Hence, the aim of the study is to determine the changes in intermolar and intercanine width when the arches are moved in the anteroposterior plane.

2. Materials and Methods

This experimental in vitro study was not carried out directly on human subjects, but scanned images of their maxillary and mandibular impressions were used, and the study was conducted after obtaining the Institutional Ethics clearance (No. IEC/E/18/2019/GDCT dated 12-11-2019). The sample consists of 48 subjects (13 males and 35 females) aged between 18 and 30 years with Angle's class I normal occlusion, well-aligned upper and lower arches with a full complement of teeth, a straight and pleasing profile, and no history of previous orthodontic or surgical orthodontic treatment. The dental casts of each subject were laser scanned with a computer-assisted, non-contact, high-definition, three-dimensional scanning system (D900; 3Shape, Copenhagen, Denmark), and the scanned images of maxillary and mandibular arches were recorded and converted to digital format. as STL files for further processing and analysis (**Figure 1**A & B). The files were refined for taking intercanine and intermolar measurements in both maxillary and mandibular arches by using Ortho Analyzer software (2020, 3Shape). In the maxillary arch, intermolar width was measured between the mesiobuccal cusp tips of the maxillary first molars, and intercanine width was measured between the cusp tips of maxillary canines. In the mandibular arch, intermolar width was measured between the mesiobuccal cusp tips of first mandibular molars, and intercanine width was measured between cusp tips of mandibular canines. (**Figure 2**A & B).

A digital geometric arch form was constructed on the occlusal surface of the digital cast for each patient. The geometric form of an ellipse was drawn by connecting the buccal cusp tip of posteriors and the incisal tip of anteriors in both maxillary and mandibular digital models. This geometric form constructed on the maxillary and mandibular arch was occluded or coincided with a class I position on the maxillary digital model (**Figure 3**). This geometric arch form was then imported to AutoCAD software (version 2014), and both maxillary and mandibular arches were occluded in class 1 molar relation projected on the image of the maxillary arch model, traced, and copied with its same dimension. A point was marked at the mesiobuccal cusp tip of the maxillary first molar on both sides over the geometric arch form, and a line was drawn connecting these two points. The corresponding points on the maxillary arch to the mandibular geometric arch form were then projected as a linear horizontal line, which coincides approximately at the mesiobuccal groove of the mandibular first molar on both sides, and these points are connected to draw a line. Similarly, a point was marked on the cusp tip of the maxillary canine over its geometric arch form on both sides, and a line was drawn connecting these two points. The corresponding points of the maxillary canine tip were projected horizontally on the mandibular arch form, which coincides between the mandibular canine and premolar over its geometric arch form. The line connecting these two points on the mandibular arch form was drawn.

Once all the points and lines were drawn in an initial class 1 molar relation, the horizontal distance between the maxillary and mandibular arch at the points selected in both arches along the x-axis was measured at both the first molar and canine region and recorded as X_0 (normal transverse width) (**Figure 4**A). Then, the mandibular geometric arch form was moved forward linearly to 3 mm with respect to the maxillary arch form. The transverse distance between the mandibular arch form at the point where the lines at the molar and canine region were drawn and its corresponding points on the maxillary arch form in an x-axis was measured, and that was recorded as value A (**Figure 4**B). The same procedure is repeated by moving the mandibular arch form forward to 6 and 9 mm with respect to the maxillary arch, and the transverse distance between the points was measured and recorded as B and C values, respectively, for the molar region. In the canine region, the transverse width was recorded at its 6 mm position only as the mandibular arch was going out of the intercanine axis of the maxillary arch when advanced to 9 mm (**Figure 4**C & D). All of the above transverse differences were measured and calculated on one side of the arch. The ratio between the value in the initial position and the values at each forward displacement was calculated and tabulated for all the subjects.

3. Results

The descriptive statistics of the average transverse width in the maxillary and mandibular arches show a mean value of 50.51 ± 2.54 mm and 43.44 ± 2.28 mm in the molar region, and 33.67 ± 2.12 mm and 26.28 ± 2.07 mm in the canine region (**Table 1**). The changes in intermolar width for the mandibular forward movement at 3 mm, 6 mm, and 9 mm show values of 0.9 ± 0.41 mm, 1.87 ± 0.69 mm, and 3.05 ± 0.93 mm, respectively. The mean changes in intermolar width are 1.97 ± 0.59 mm and are statistically significant with a p-value < 0.001 (**Table 2**). The changes in intercanine width for the mandibular forward movement at 3 mm and 6 mm show a value of 2.32 ± 0.9 mm and 5.73 ± 1.68 mm, respectively. The mean changes in intercanine width are 4.03 ± 1.18 mm and are statistically significant with a p-value < 0.001 (**Table 3**).

The changes in intermolar width per mm for the mandibular forward movement at 3 mm, 6 mm, and 9 mm showed values of 0.29 ± 0.12 mm, 0.31 ± 0.11 mm, and 0.35 ± 0.12 mm, respectively. The mean changes in intermolar width were calculated to be 0.32 ± 0.1 mm per mm (**Table 4** and **Figure 5**), which is statistically significant with p value = 0.019.The changes in intercanine width per mm for the mandibular forward movement at 3 mm and 6 mm showed a value of 0.73 ± 0.24 mm and 0.9 ± 0.32 mm, respectively. The mean changes in intercanine width are calculated to be 0.81 ± 0.25 mm per mm (**Table 5** and **Figure 6**) and are statistically significant with a p-value = 0.005.

When we compared the dental arches during mandibular movement sagittally at 3 mm, 6 mm, and 9 mm between the lowest and highest transverse width range groups, a mean value of 0.35 ± 0.08 mm and 0.35 ± 0.13 mm, respectively, in the molar region and 0.80 ± 0.25 mm and 0.89 ± 0.28 mm, respectively, in the canine region were obtained (**Figure 7**) and was statistically insignificant (**Table 6**). Based on the overall assessment of intermolar and intercanine changes from the lowest to the highest transverse width of dental arches, a prediction chart can be prepared for the changes in each millimeter of arch movement. The assessment of changes in intermolar and intercanine width against the maxillary width is shown using a prediction chart (**Table 7**). An average predicted value of 0.32 ± 0.1 mm in the molar region and 0.81 ± 0.25 mm in the canine region on one side of the arch was obtained. So the transverse width change is approximately 1:0.3 mm and 1:0.8. mm in the molar and canine regions, respectively, on one side of the arch and 1:0.6 mm and 1:1.6 mm for the arch.

The relationship between the transverse intermolar and intercanine width with the changes during sagittal movements was statistically analyzed using the ANOVA test and regression analysis. The ANOVA test showed the calculated values of the F test as 1.814 and 0.782, respectively, which were statistically not significant (p value > 0.05) (**Table 8**). The regression graph using a scatter plot also showed that the variables were not statistically significant (**Figure 8**).

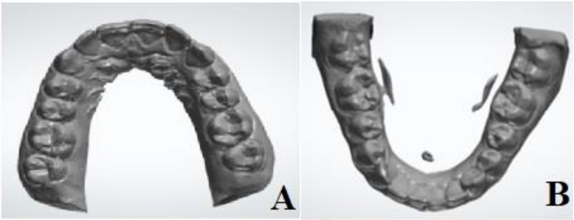

Figure 1: Scanned images of dental arches; **A:** Maxillary; **B:** Mandibular

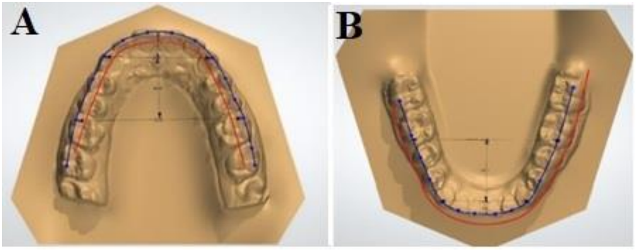

Figure 2: Meaurement of the transverse intermolar and intercanine width on digital cast; **A:** Maxillary; **B:** Mandibular

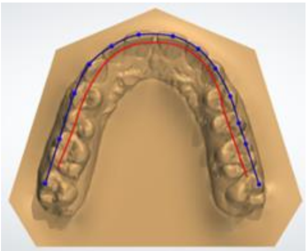

Figure 3: Geometric arch form constructed on 3D digital models coordinated in maxillary arch.

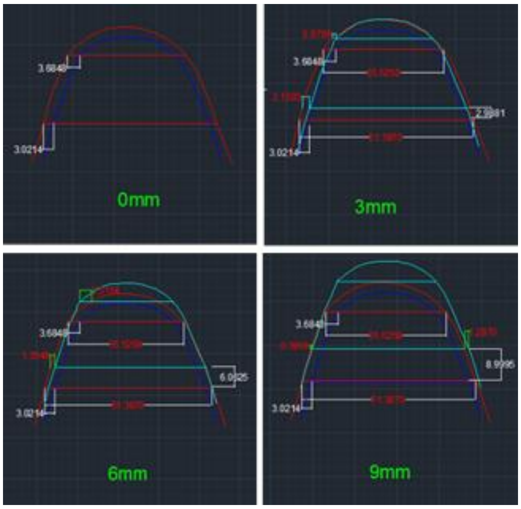

Figure 4: Meaurement of transverse width changes; **A:** initial (X_0); **B:** at 3mm; **C:** at 6mm and **D:** at 9mm.

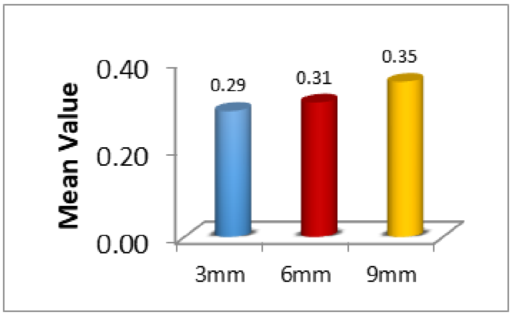

Figure 5: Comparison of changes in intermolar width per mm when mandibular arch is moved sagittally at 3mm, 6mm and 9mm

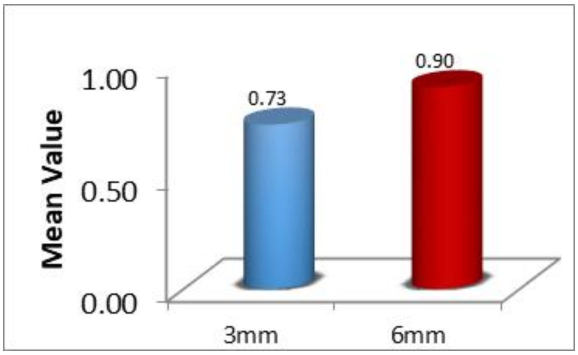

Figure 6: Comparison of changes in intercanine width per mm when mandibular arch is moved sagittally at 3mm and 6mm respectively

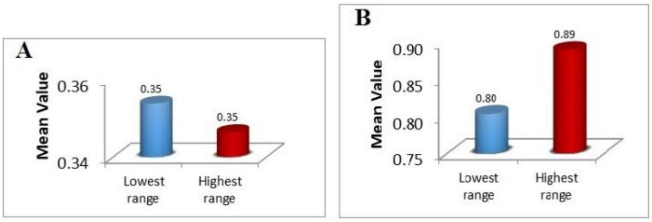

Figure 7: Comparison of changes in arch width between wide and narrow arches; **A:** Intermolar region; **B:** Intercanine region

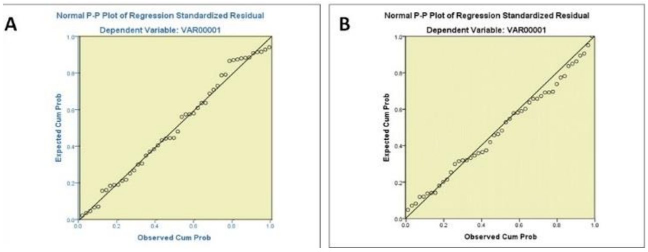

Figure 8: Scatter plot showing arch width and changes in sagittal movement; **A:** Intermolar region; **B:** Intercanine region

Table 1: Average transverse intermolar and intercanine width in normal occlusion

Intermolar width	N	Mean ± SD	Median (IQR)
Maxilla	48	50.51 ± 2.54	50.58 (48.77 -52.07)
Mandible	48	43.44 ± 2.28	43.34 (41.59 - 45.5)
Intercanine width			
Maxilla	48	33.67 ± 2.12	33.73(32.45- 35.44)
Mandible	48	26.28 ± 2.07	26.24(25.05- 27.46)

Table 2: Comparison of changes in intermolar width when mandibular arch is moved sagittally at 3mm, 6mm and 9mm respectively

Movement	Mean ± SD	Median (IQR)	Minimum	Maximum	p value
3mm	0.9 ± 0.41	0.86(0.64- 1.15)	0.18	2.02	< 0.001
6mm	1.87± 0.69	1.69(1.39- 2.44)	0.58	3.55	
9mm	3.05± 0.93	3 (2.33 - 3.67)	1.50	5.66	
Overall	1.97± 0.59	1.92 (1.5 - 2.42)	0.92	3.55	

Table 3: Comparison of changes in intercanine width when mandibular arch is moved sagittally at 3mm and 6mm respectively

Movement	Mean ± SD	Median (IQR)	Minimum	Maximum	p value
3mm	2.32 ± 0.9	2.34(1.88- 2.76)	0.29	5.64	< 0.001
6mm	5.73 ± 1.68	5.19(4.58- 6.72)	2.81	10.30	
Overall	4.03 ± 1.18	3.77(3.13- 4.84)	1.55	7.97	

Table 4: Comparison of changes in intermolar width per mm when mandibular arch is moved sagittally at 3mm, 6mm and 9mm respectively

Movement	Mean ± SD	Median (IQR)	Minimum	Maximum	p value*
3mm	0.29 ± 0.12	0.27 (0.2 - 0.38)	0.08	0.58	0.019
6mm	0.31 ± 0.11	0.3 (0.22 - 0.41)	0.09	0.52	
9mm	0.35 ± 0.12	0.34(0.25 -0.44)	0.16	0.62	
Overall	0.32 ± 0.1	0.31 (0.25 - 0.4)	0.14	0.52	

*Significant at 0.05 level

Table 5: Comparison of changes in intercanine width per mm when the mandibular arch is moved sagittally at 3mm and 6mm respectively

Movement	Mean ± SD	Median (IQR)	Minimum	Maximum	p value*
3mm	0.73±0.24	0.79(0.6 - 0.85)	0.09	1.33	0.005
6mm	0.9 ± 0.32	0.88(0.72-1.14)	0.02	1.63	
Overall	0.81±0.25	0.82(0.65-0.99)	0.16	1.33	

*Significant at 0.01 level.

Table 6: Comparison of changes in intermolar and intercanine width between wide and narrow arches

Intermolar width	Mean	SD	N	t	P
Lowest range	0.35	0.08	4	0.1	0.920
Highest range	0.35	0.13	7		
Intercanine width				0.51	0.620
Lowest range	0.80	0.25	4		
Highest range	0.89	0.28	7		

Table 7: Prediction of transverse width changes per mm

	Intermolar width			Intercanine width		
S.No	**Maxilla**	**Mandible**	**Transverse change**	**Maxilla**	**Mandible**	**Transverse change**
1	45.94	38.97	0.455	26.97	24.69	0.83
2	45.99	40.65	0.28	30.04	25.35	1.055

3	46.11	39.44	0.395	30.14	23.68	0.82
4	46.61	40.79	0.295	30.14	24.83	1.15
5	46.87	38.7	0.385	30.64	24.48	1.05
6	47.63	40.75	0.52	31.22	23.97	0.755
7	47.71	40.06	0.155	31.46	23.03	0.82
8	48.01	44.04	0.445	31.5	23	0.595
9	48.07	41.84	0.24	31.7	25.64	1.075
10	48.44	42.93	0.365	32.01	25.66	0.675
11	48.57	42.92	0.255	32.17	23.67	1.325
12	48.7	41.02	0.235	32.4	26.71	1.06
13	48.98	41.39	0.4	32.58	26.91	0.975
14	49	42.77	0.265	32.78	24.52	0.945
15	49.12	41.5	0.18	32.79	23.64	0.65
16	49.25	42.86	0.46	32.86	25.19	0.53
17	49.3	41.08	0.135	32.86	25.88	0.18
18	49.31	42.03	0.31	32.91	26.59	0.645
19	49.52	41.43	0.135	33.01	28.02	0.475
20	49.64	43.17	0.265	33.39	27.28	1.185
21	49.91	44.42	0.26	33.5	22.97	0.71
22	50.04	43.25	0.385	33.52	25.62	0.83
23	50.07	43.42	0.34	33.59	25.59	0.975
24	50.53	42.59	0.25	33.66	29.68	0.99
25	50.62	44.55	0.435	33.8	27.7	0.62
26	50.72	43.91	0.28	33.87	27.04	0.73
27	50.96	44.9	0.48	34.25	27.83	1.055
28	51.22	43.42	0.4	34.29	26.14	0.99
29	51.22	42.58	0.145	34.35	25	0.805
30	51.25	42.52	0.24	34.49	26.33	0.805
31	51.28	43.57	0.33	34.91	27.49	1.045
32	51.37	42.6	0.255	34.91	27.49	0.82
33	51.39	46.2	0.29	34.94	25.57	0.895
34	51.44	44.47	0.19	34.96	27.11	0.705
35	51.62	45.56	0.35	35.09	27.4	0.745
36	52.05	45.97	0.45	35.42	28.81	0.945
37	52.08	43.44	0.38	35.45	26.63	0.65
38	52.32	44.93	0.31	35.63	28.1	0.93
39	52.63	46.21	0.295	35.78	28.57	0.72
40	53.13	45.72	0.365	35.78	25.43	0.645
41	53.28	46.91	0.4	35.8	23.81	0.16
42	53.55	46.08	0.435	35.81	28.6	1.05
43	53.71	46.75	0.36	35.85	27.28	0.615
44	54.02	45.32	0.51	35.86	27.37	1.255
45	54.54	46.42	0.29	36.06	27.48	0.8
46	55.03	46.75	0.23	36.33	26.69	0.275
47	55.51	46.88	0.155	36.36	25.71	0.98
48	56.44	47.39	0.405	38.12	25.34	0.545

Table 8: ANNOVA test to compare between transverse width and changes during sagittal movement

Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	149.640	4	37.410	1.814	.144[b]
	Residual	886.570	43	20.618		
	Total	1036.210	47			
a. Dependent Variable: maxillary intermolar width						
b. Predictors: (Constant),X_0, A,B,C.						

Intermolar width						
Intercanine width						
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	22.443	3	7.481	782	.510[b]
	Residual	420.773	44	9.563		
	Total	443.216	47			
a. Dependent Variable: maxillary inercanine width.						
b. Predictors: (Constant),X_0, A, B.						

4. Discussion

Arch width is one of the parameters in deciding the arch form and dimensional changes of dental arches would lead to the development of various intra-arch and inter-arch discrepancies. Arch width changes must not be considered separately, and the interdependence of the arches has significant implications in arch coordination. Although several studies used cephalometrics [17,18,19,20,21,22,23,24,25] study models,[23] CBCT, and scanned images of maxillary and mandibular models,[26,27,28] geometric arch forms can be used as one of the best references to evaluate changes in arch form.

Many investigators have reported studies on the dental arch form, its coordination and changes in transverse width. Kook et al[29] in his study coordinated the dental arch 3-dimensionally using a CAD program along the facial axis and bracket slot. Taner et al. evaluated longitudinal arch width and form changes and defined arch form types with computer-generated Bezier arch curves.[30] Braun et al. used the beta function for dental arch fitting. In Class I, Class II, and Class III malocclusions,[31] Zou et al. in this study compared the dental and basal arch form in class III malocclusion and found moderate to high correlation between them,[32] Fu et al. in his study used the beta function to compare the dental and basal ACH forms in class II malocclusion.[33]

In the present study, using the elliptical arch form obtained from the digital model, dynamic measurements were made by simulating the sagittal movement of the mandibular arch forward using the AutoCAD software to measure the changes in transverse width between the arches at specific landmarks in the molar and canine region. Use of digital methods provides the exact numerical value of the difference between the dental arches, which leads to more accurate decision-making and lowers human errors. As shown in the study, the digital method increased the accuracy of measurements, which was documented by Chung and Wolfgramm, correlating the perimeter of the ellipse to the maxillary arch perimeter using the Ramanujan's equation.[8]

The transverse intermolar and intercanine widths of maxillary and mandibular arches were taken directly from the scanned images at specific anatomic landmarks marked digitally. It was found that in the maxillary arch, the mean transverse intermolar width was 50.51 ± 2.54 mm, and the mean mandibular intermolar width was 43.44 ± 2.28 mm. The intercanine width in the maxillary arch shows a mean value of 33.67 ± 2.12 mm, and the mandibular intercanine width shows a mean of 26.28 ± 2.07 mm. Bishara et al. in his longitudinal study evaluated the changes in intercanine and intermolar widths over a 45-year span, in which he used the cusp tip of the canine and the mesiobuccal cusp tip of the molars to measure the arch width. Tancan Uysal, in his study, while comparing the arch width of class III with normal occlusion, used the cuspal tip for the arch width measurements. Sayin and Turkkahraman, in their study to compare dental arch and alveolar widths of patients with Class II, Division 1 malocclusion and subjects with Class I ideal occlusion, used cuspal tips for the arch width measurements.[12] All of their values of arch width correlate well with the present study.

From the results obtained, the average change of transverse width calculated per mm at molars was found to be 0.32 ± 0.1 mm, and at canines was 0.81 ± 0.25 mm, which is a statistically significant change, and no significant difference was noticed in samples having the highest and lowest arch widths. This prediction may guide the clinicians regarding the transverse arch width coordination during surgical orthodontic treatments in skeletal malocclusions.

5. Limitations

The relatively small sample size in this study was one of the drawbacks in framing a prediction. The gender difference in arch form was documented in many studies and no separate values were taken for males and females in the present study.[34,35] Though the digital measurements are accepted to be accurate, errors in manual markings of the anatomic points on the scanned images might influence the arch form, and since the measurements were done by only one investigator, the possibility of human error cannot be omitted also. The transverse difference calculated in this study was done on only one side of the arch, and the prediction was made with the value obtained on a single side, which may also affect the significance of the result. The samples of this study were adults. Above 18 years of age, and the data can be interpreted for surgical orthodontic cases only and may not be suitable for functional jaw orthopaedics and other growth modification procedures. Dental compensations in the transverse plane are a common finding in many skeletal class II and class III malocclusions, and the application of this data has to be done with caution until otherwise the posteriors are decompensated.

6. Conclusions

This cross-sectional study with individuals having normal occlusion has assessed the average transverse intermolar and intercanine width when the jaws were moved sagittally using a geometric arch form, and the following conclusions were drawn.

1. There was a normal range of difference existing in the transverse intermolar and intercanine regions in normal occlusion at fixed anatomic landmarks on the maxillary and mandibular arches.
2. Arch width was changing progressively in the intermolar and intercanine regions when the mandibular arch moved sagittally.
3. There was a mean difference of 1.97 ± 0.59 mm in the intermolar region and 4.03 ± 1.18 mm in the intercanine region when the arches moved 3 mm, 6 mm, and 9 mm, respectively, on one side of the arch.
4. The average predicted transverse difference of dental arches per mm on one side of the arch was 0.32 ± 0.1 mm at molar and 0.81 ± 0.25 mm at canine regions, respectively.
5. The ratio of mandibular arch sagittal movement to transverse arch width change is 1:0.3 mm in the molar region and 1:0.8 mm in the canine region per side.

7. Source of Funding

None.

8. Conflict of Interest

None.

9. References

1. Banker AM, Pillai JP, Patel KD. Determination of normal maxillary transverse dimension by using intercanine width and interpalatal first molar width. *Indian J Dent Res*. 2016;27(5):468–72. doi: 10.4103/0970-9290.195614.
2. McNamara JA. Maxillary transverse deficiency. *Am J Orthod Dentofacial Orthop*. 2000;117(5):567–70.
3. Andrews LF. The 6-elements orthodontic philosophy: Treatment goals, classification, and rules for treating. *Am J Orthod Dentofacial Orthop*. 2015;148(6):883–7.
4. Vanarsdall-Jr RL. Transverse dimension and long-term stability. *Semin Orthod*. 1999;5(3):171–80.
5. CH Chung. Diagnosis of transverse problems. *Semin. Orthod*. 2019;25(1):16–23.
6. Currier JH. A computerized geometric analysis of human dental arch form. *Am J Orthod*. 1969;56(2):164–79.
7. Chung DD, Wolfgramm R. Maxillary arch perimeter prediction using Ramanujan's equation for the ellipse. *Am J Orthod Dentofacial Orthop*. 2015;147(2):235–41.
8. Lee RT. Arch width and form: a review. *Am J Orthod Dentofacial Orthop*. 1999;115(3):305–13.
9. Hawley CA. Determination of the normal arch and its application to orthodontia. *Dent Cosmos*. 1905;47(5):541–52.
10. BeGole EA. Application of the cubic spline function in the description of dental arch form. *J Dent Res*. 1980;59(9):1549–56. doi: 10.1177/00220345800590092901.
11. Taner TU, Ciger S, El H, Germec D, Es A. Evaluation of dental arch width and form changes after orthodontic treatment and retention with a new computerized method. *Am J Orthod Dentofacial Orthop*. 2004;126(4):464–75.
12. Nie Q, Lin J. A comparison of dental arch forms between Class II Division 1 and normal occlusion assessed by Euclidean distance matrix analysis. *Am J Orthod Dentofacial Orthop*. 2006;129(4):528–35.
13. Bishara SE, Jakobsen JR, Treder J, Nowak A. Arch width changes from 6 weeks to 45 years of age. *Am J Orthod Dentofacial Orthop.* 1997;111(4):401–9. doi: 10.1016/s0889-5406(97)80022-4..
14. Uysal T, Memili B, Usumez S, Sari Z. Dental and alveolar arch widths in normal occlusion, class II division 1 and class II division 2. *Angle Orthod*. 2005;75(6):941–7.
15. Sayin MO, Turkkahraman H. Comparison of dental arch and alveolar widths of patients with Class II, division 1 malocclusion and subjects with Class I ideal occlusion. *Angle Orthod*. 2004;74(3):356–60.
16. R. Adaskevicius, A. Vasiliauskas. Evaluation of Dental Arch Form Using 3D Dental Cast Scanning Technology. *Electronics Electrical Eng*. 2009;93(5):99–102.
17. Grippaudo C, Oliva B, Greco A, Sferra S, Deli R. Relationship between vertical facial patterns and dental arch form in class II malocclusion. *Prog Orthod.* 2013;14:43.
18. Lux CJ, Conradt C, Burden D, Komposch G. Transverse development of the craniofacial skeleton and dentition between 7 and 15 years of age--a longitudinal postero-anterior cephalometric study. *Eur J Orthod*. 2004;26(1):31–42.
19. Athanasiou, Droschl, and Bosch. Data and patterns of transverse dentofacial structure of 6- to 15-year-old children: A posteroanteriorcephalometric study. *Am J Orthod Dentofacial Orthop*. 1992;101(5):465–71. doi: 10.1016/0889-5406(92)70121-P.
20. Woods GA. Changes in width dimensions between certain teeth and facial points during human growth. *Am J Orthod*. 1950;36(9):676–700.
21. Snodell SF, Nanda RS, Currier GF. A longitudinal cephalometric study of transverse and vertical craniofacial growth: *Am J Orthod Dentofacial Orthop*. 1993;104(5):471–83.
22. Howes AE: Case analysis and treatment planning based upon the relationship of the tooth material to its supporting bone. *Am J Orthod*. 1947;33(8):499–533.
23. Bondevik O. Changes in occlusion between 23 and 34 years. *Angle Orthod* 1998;68(1):75–80.
24. Ricketts RM. Perspectives in the clinical Application of Cephalometrics- The first fifty years. *Angle Orthod*. 1981;51(2):115–50.
25. RHW Tibana, Palagi, Miguel. Changes in Dental Arch Measurements of Young Adults with Normal Occlusion—A Longitudinal Study. *Angle Orthod*. 2004;74(5):618–23.
26. Gupta KK, Sawhney H, Faisal M, Sasikumar A, Kashwani R. Evaluation of Unilateral Transmigration of Cuspid Tooth in Mandibular Arch using 3D Imaging. *Int Res J Multidiscip Scope*. 2024;5(4):661–7.
DOI: https://doi.org/10.47857/irjms.2024.v05i04.01206
27. Hayes J. Proposed clinical skeletal transverse measurement technique - palpation adjacent to the molars. *Orthod Pract*. 2011;2(2):1–4.
28. Tavares A, Braga E, Araujo TM. Digital models: How can dental arch form be verified chairside?. *Dental Press J Orthod*. 2017;22(6):68–73.
29. Mude NN, Dhond SN, Khedkar KR, Kaur T, Faisal M, Kashwani R et al. Controversies around Orthodontic Treatment and TMD Etiologies. *Dent Dent Pract* J. 2024;6(2):180092.
30. Taner TU, Ciger S, El H, Germec D, Es A. Evaluation of dental arch width and form changes after orthodontic treatment and retention with a new computerized method. *Am J Orthod Dentofacial Orthop*. 2004;126(4):464–75.
31. Braun S, Hnat WP, Fender DE, Legan HL. The form of the human dental arch. *Angle Orthod*. 1998;68(1):29–36.

32. Zou W, Jiang J, Xu T, Wu J. Relationship between mandibular dental and basal bone arch forms for severe skeletal Class III patients. *Am J Orthod Dentofacial Orthop*. 2015;147(1):37–44.
33. Fu K, Fang S, Fan X, Liu C, Zhang C, Liu J et al. Analysis of dental and basal bone arch form correlations in skeletal Class II malocclusion. *Am J Orthod Dentofacial Orthop*. 2021;159(2):202–9.
34. Oliva B, Sferra S, Greco A, Valente F, Grippaudo C. Three-dimensional analysis of dental arch forms in Italian Population. *Prog Orthod*. 2018;19(1):34.
35. Raberin M, Laumon B, Martin JL, Brunner F. Dimensions and form of dental arches in subjects with normal occlusion. A*m J Orthod Dentofacial Orthop*. 1993;104(1):67–72.

Cite this article: Dharshini CP, Kumar GS, Pillai B. Prediction of transverse width changes of dental arches during maxillomandibular sagittal movement using a geometric model. *IP Indian J Orthod Dentofacial Res.* 2025;11(1):51-59.