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Evaluation of Dentoalveolar Symmetries in Angle's Class I Normal Occlusion, Class II Division 1 and Class II Subdivision Malocclusion

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KEYWORDS

Symmetry, orthodontic diagnosis, inter-arch, subdivision, malocclusions.

ABSTRACT:

Introduction: Dental and alveolar symmetry are essential components of orthodontic diagnosis and treatment planning, significantly impacting both occlusal relationships and facial aesthetics. Symmetry in dental arches is critical for maintaining a functional occlusion and achieving a harmonious facial appearance. Discrepancies in tooth size, developmental disturbances, and external factors such as habits or trauma can lead to dental asymmetries.

Objectives: This study aimed to evaluate and compare inter-arch dental and alveolar symmetry in transverse and anteroposterior planes and analyze mesiodistal tooth widths across Angle's Class I normal occlusion, Class II Division 1, and Class II subdivision malocclusions.

Methods: A total of 140 dental casts, comprising 50 samples each for Class I and Class II Division 1 and 40 for Class II subdivision malocclusion, were analyzed. Subjects aged 18–30 years were selected based on specific inclusion and exclusion criteria. Measurements were performed using vernier calipers to assess 24 transverse, 12 anteroposterior, and 24 mesiodistal parameters. Data were evaluated for symmetry between the right and left sides across the malocclusion groups.

Results: Angle Class I and Class II Division 1 malocclusions displayed symmetry in alveolar lengths and inter-arch measurements. However, statistically significant inter-arch asymmetries were identified in Angle Class II subdivision malocclusion for transverse and anteroposterior parameters. Mesiodistal tooth widths showed no significant asymmetries in the measured distances for teeth 1-6 across all malocclusion classes.

Conclusions: Inter-arch asymmetry was predominantly observed in Angle Class II subdivision malocclusion, whereas Class I and Class II Division 1 malocclusions demonstrated symmetry across the evaluated parameters. These findings emphasize the importance of detailed symmetry assessment in orthodontic diagnosis and treatment planning to achieve functional and aesthetic outcomes.

1. Introduction

Dental and alveolar symmetry are essential components of orthodontic diagnosis and treatment planning, significantly impacting both occlusal relationships and facial aesthetics. Asymmetries in the transverse and anteroposterior dimensions can pose challenges in achieving optimal functionality and appearance of the dentition [1,2]. For orthodontists, understanding and evaluating these asymmetries is crucial for delivering

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comprehensive care and formulating treatment plans that address both functional and aesthetic concerns.[3]

Angle's Classification of Malocclusion provides a foundational framework for diagnosing and understanding various malocclusion patterns. Introduced by Edward H. Angle in the late 19th century, this classification system categorizes malocclusions based on the relationship of the permanent first molars. Angle's Class-I malocclusion is characterized by a mesiobuccal cusp of upper 1st molar on mesial groove of lower 1st molar, though it may include crowding, rotations, or spacing issues. Class-II Division-1 malocclusion involves the mesial positioning of the maxillary first molar relative to the mandibular first molar, frequently accompanied by protruded maxillary incisors. Class-II subdivision malocclusion presents a unilateral discrepancy, where one side exhibits a Class-I relationship and the other side shows a full cusp Class-II relationship [4,5]

Symmetry in dental arches is critical for maintaining a functional occlusion and achieving a harmonious facial appearance. Discrepancies in tooth size, developmental disturbances, and external factors such as habits or trauma can lead to dental asymmetries [6]. Alveolar symmetry, which pertains to the bone structures supporting the teeth, can also be affected by similar factors. Both dental and alveolar asymmetries can contribute to malocclusions, influencing treatment strategies and outcomes [7-8].

Study by Staab [4], have explored variations in dental arch forms and their implications for orthodontic treatment. These findings highlight the necessity of a detailed assessment of symmetry in different malocclusion categories to ensure effective treatment and optimal outcomes.

This study assessed intra-arch dental symmetry in the transverse plane at key tooth regions for Angle's Class-I, Class-II Division-1, and Class-II subdivision malocclusions, compared mesiodistal tooth widths at canine, premolar and molar region on right and left sides and their impact on occlusion, and evaluated dental symmetry in the anteroposterior plane.

2. Methods

A total of 140 dental casts (calculated with help of Bernard Rosner. Fundamentals of Biostatistics (5th edition). (Based on equation 8.27)) of subjects aged 18-30 years were analysed, with 50 samples each for Class I and Class II Division 1 and 40 for Class II subdivision malocclusion. Measurements were taken using a vernier calliper from 24 transverse parameter as stated in Table 1, 12 anteroposterior parameters as stated in Table 2 and 24 mesiodistal parameters as stated in Table 3.
Subjects were selected based on specific inclusion and exclusion criteria. Criteria for Class I included well-aligned arches with minor spacing or crowding, a good facial profile, coinciding midlines, and fully erupted permanent teeth, up to second molars. Class II Division 1 required a bilateral Class II molar relationship, and Class II subdivision included a unilateral Class I/full cusp Class II molar relationship. Exclusion criteria for all groups involved significant dental or medical history, previous orthodontic or facial treatments, facial asymmetry, gingival issues, and early molar extractions.

The method involved clinical examination to select subjects based on occlusion criteria, excluding those with facial asymmetry or occlusal cant, which was examined visually by comparing the right and left sides of the face. Occlusal cant was evaluated by placing a metal scale between the upper and lower teeth. The line of scale was related to inter pupillary line. If scale was parallel to inter pupillary line, it indicated the absence of occlusal cant. Upper and lower impressions were taken using alginate, disinfected, and poured in dental stone. Study models were prepared with maxillary and mandibular casts aligned on parallel planes of the instrument. (Fig 1). A midpalate reference line was marked on the upper casts using anatomical landmarks, and this line was transferred to the lower casts for consistency (Fig 2). Measurements of transverse and mesiodistal dimensions were taken directly from the casts (Fig 3,4), while anteroposterior measurements were made from photocopied casts (Fig 5).

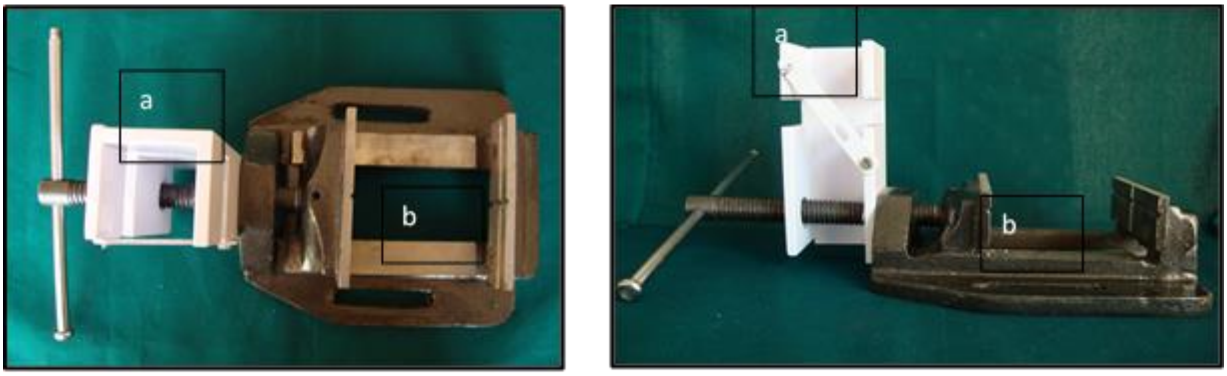

Fig 1: Customized instrument. A- top view. B- Front view a. for stabilizing and moving vernier calliper b. for stabilizing the dental cast.

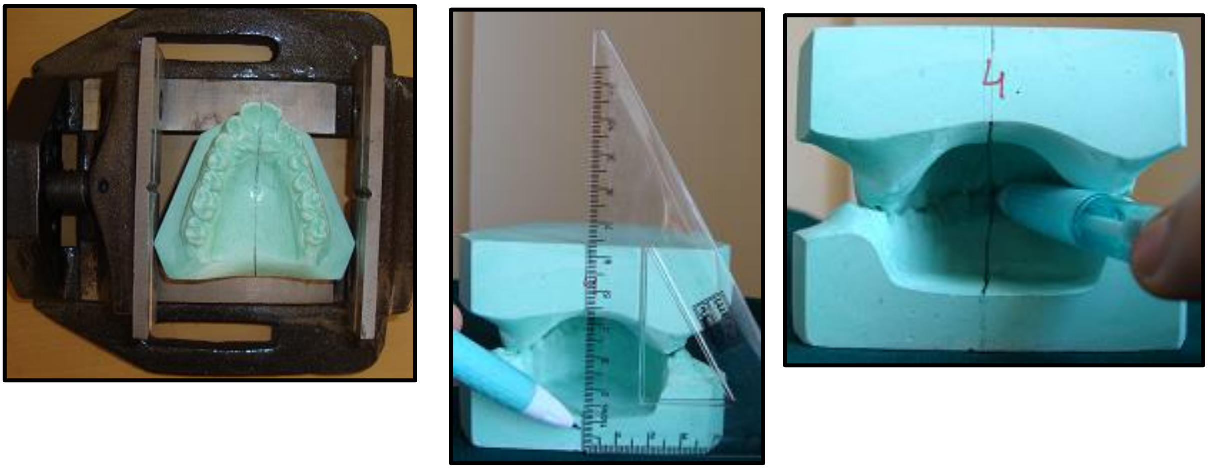

Fig 2: Maxillary Cast was stabilized using vice to draw upper midline. Midline transfer process. A- Upper reference midline was transferred to the lower cast (posterior reference point) with the help of setsquare as shown in the diagram. B- Marking of anterior reference point at the junction where the upper reference line touches lower anterior dentition.

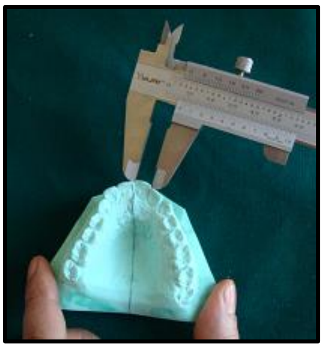

Fig 3 : Mesiodistal crown measurement

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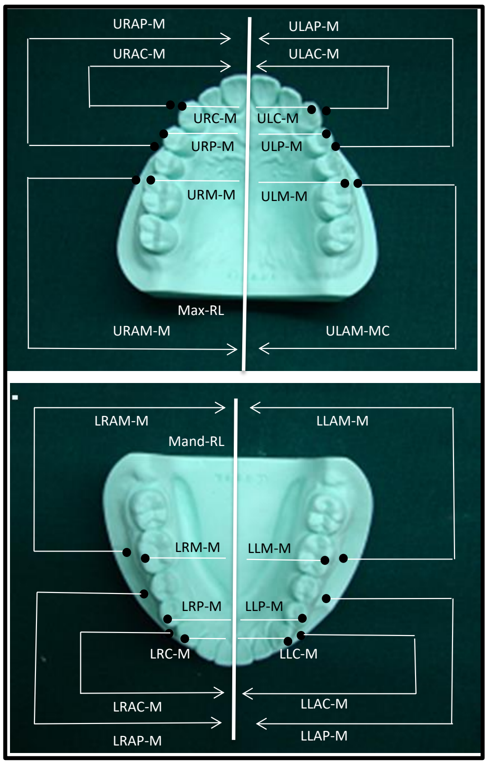

Fig 4: Linear transversal measurements made from dental and alveolar landmarks to the reference lines on the maxillary and mandibular dental casts. Max- RL (maxillary reference midline), Mand-RL (mandibular reference midline).

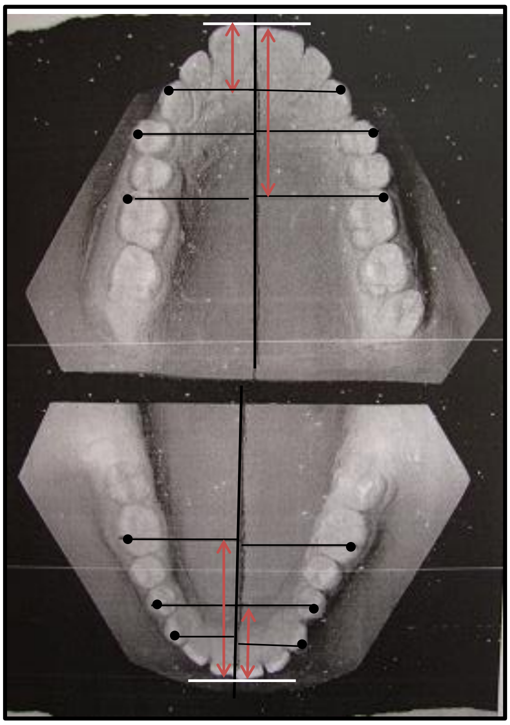

Fig 5: Anteroposterior measurements on photocopied of upper and lower casts.

Transverse measurements

24 points were marked on the upper and lower dental casts. Using these points, 12 measurements were taken on upper and lower casts. Description for all these measurements (widths) are as follows: -

Sl no	Measurements	Description
1.	UR C-M / UL C-M	Distance from upper right/left canine cusp tips to reference midline.
2.	LR C-M / LL C-M	Distance from lower right/left canine cusp tips to reference midline.
3.	UR P-M / UL P-M	Distance from upper right/left premolar cusp tips to reference midline.
4.	LR P-M / LL P-M	Distance from lower right/left premolar cusp tips to reference midline.
5.	UR M-M / UL M-M	Distance from upper right/left molar mesiobuccal cusp tips to reference midline.
6.	LR M-M / LL M-M	Distance from lower right/left molar buccal grooves to reference midline.
7.	UR AC-M / UL AC-M	Distance from upper right/left alveolar canine mucogingival junction to reference midline.
8.	LR AC-M / LL AC-M	Distance from projected upper right/left alveolar canine points on the mandibular cast to reference midline.

9.	UR AP-M / UL AP-M	Distance from mucogingival junctions above interdental contact points of upper right/left premolars to reference midline.
10.	LR AP-M / LL AP-M	Distance from projected lower right/left alveolar premolar points on the mandibular cast to reference midline.
11.	UR AM-M / UL AM-M	Distance from mucogingival junctions above mesiobuccal cusp tips of upper right/left first molars to reference midline.
12.	LR AM-M / LL AM-M	Distance from projected upper right/left alveolar molar points on the mandibular cast to reference midline.

Table 1: Transverse measurements for symmetry analysis

Anteroposterior Measurements

The maxillary and mandibular casts were photocopied after marking the reference midline and key anatomical points. On the maxillary cast, the right and left canine cusp tips, first premolar cusp tips, and mesiobuccal cusp tips of the first molars were marked. For the mandibular cast, the right and left canine cusp tips, first premolar cusp tips, and buccal grooves of the first molars were marked. Perpendicular projections of the most proclined teeth were used to define anterior and posterior points on the reference midline, and 12 measurements were taken from these points.

Sl no	Measurement	Description
1.	UR C-AL	Upper right canine arch length - Distance from anterior landmark to perpendicular from right canine
2.	UL C-AL	Upper left canine arch length - Distance from anterior landmark to perpendicular from left canine
3.	UR PM-AL	Upper right premolar arch length - Distance from anterior landmark to perpendicular from right premolar
4.	UL PM-AL	Upper left premolar arch length - Distance from anterior landmark to perpendicular from left premolar
5.	UR M-AL	Upper right molar arch length - Distance from anterior landmark to perpendicular from right molar
6.	UL M-AL	Upper left molar arch length - Distance from anterior landmark to perpendicular from left molar
7.	LR C-AL	Lower right canine arch length - Distance from anterior landmark to perpendicular from right canine
8.	LL C-AL	Lower left canine arch length - Distance from anterior landmark to perpendicular from left canine
9.	LR PM-AL	Lower right premolar arch length - Distance from anterior landmark to perpendicular from right premolar
10.	LL PM-AL	Lower left premolar arch length - Distance from anterior landmark to perpendicular from left premolar
11.	LR M-AL	Lower right molar arch length - Distance from anterior landmark to perpendicular from right molar
12.	LL M-AL	Lower left molar arch length - Distance from anterior landmark to perpendicular from left molar

Table 2: Anteroposterior measurements for symmetry analysis

Mesiodistal measurements

Maxillary and mandibular casts were divided into right and left halves, into four quadrants. Four measurements were taken into consideration for measuring mesiodistal diameters.

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Sl no	Measurement	Description
1.	UR1-6	Upper right central incisor to first molar - sum of measurements of upper right teeth
2.	UL1-6	Upper left central incisor to first molar - sum of measurements of upper left teeth
3.	LR1-6	Lower right central incisor to first molar - sum of measurements of lower right teeth
4.	LL1-6	Lower left central incisor to first molar - sum of measurements of lower left teeth

Table 3: Mesiodistal measurements for symmetry analysis

3. Results

This study evaluated intra-arch dental and alveolar symmetry on the right and left sides, the analysis of inter-arch symmetry for the parameter distances between teeth 1 and 6 on the right and left sides and analysed inter-arch asymmetry in alveolar lengths (AL) on the right and left sides for Angle Class I normal occlusion, Angle Class II Division 1, and Angle Class II subdivision malocclusions.

Comparison of Right and Left Side Transverse Measurements for Maxillary and Mandibular Dental and Alveolar Arches in Angle Class I Normal Occlusion, Angle class II Division 1, Angle class II subdivision :-

The study evaluated inter-arch dental and alveolar symmetry on the right and left sides in Angle Class I normal occlusion, Angle Class II Division 1, and Angle Class II subdivision malocclusions

Parameters	Angle Class I Normal Occlusion			Angle class II Division 1			Angle class II Subdivision		
	Right side	Left side	p Value	Right side	Left side	p Value	Right side	Left side	p Value
	Mean ± SD (n=50)	Mean ± SD (n=50)		Mean ± SD (n=50)	Mean ± SD (n=50)		Mean ± SD (n=40)	Mean ± SD (n=40)	
UC-M	16.41 ± 1.17	16.10 ± 0.96	0.15	15.73 ± 1.33	15.02 ± 1.44	0.012*	16.21 ± 1.67	15.99 ± 1.55	0.53
UP-M	20.22 ± 1.04	19.88 ± 1.07	0.11	19.06 ± 1.45	18.47 ± 1.48	0.046*	19.81 ± 1.94	19.33 ± 1.82	0.25
UM-M	25.57 ± 1.45	25.31 ± 1.21	0.37	24.37 ± 1.68	23.59 ± 1.75	0.025*	25.33 ± 1.84	24.82 ± 1.78	0.22
UAC-M	17.54 ± 1.38	17.54 ± 1.23	1.00	16.46 ± 1.29	16.36 ± 1.22	0.69	11 ± 1.58	12.89 ± 1.67	0.0001**
UAP-M	23.89 ± 1.53	23.77 ± 1.34	0.68	23.32 ± 3.45	23.13 ± 3.32	0.77	15.67 ± 1.80	16.71 ± 1.86	0.013*
UAM-M	28.22 ± 1.36	27.99 ± 1.30	0.39	27.20 ± 1.71	26.93 ± 1.59	0.42	22.31 ± 1.75	23.11 ± 1.91	0.055

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LC-M	11.81 ± 1.01	12.24 ± 0.89	0.027*	11.29 ± 1.53	12.52 ± 1.20	0.0001**	17.15 ± 1.42	17.29 ± 1.34	0.66
LP-M	15.84 ± 1.14	16.48 ± 1.04	0.004**	15.40 ± 1.41	16.52 ± 1.38	0.0001**	23.73 ± 1.52	23.24 ± 1.53	0.16
LM-M	22.30 ± 1.36	23.09 ± 1.28	0.004**	21.96 ± 1.70	23.07 ± 1.50	0.001**	27.95 ± 1.70	27.43 ± 1.67	0.17
LAC-M	15.97 ± 1.60	16.29 ± 1.53	0.31	13.03 ± 1.39	13.30 ± 1.16	0.29	14.19 ± 1.47	14.93 ± 1.53	0.031*
LAP-M	22 ± 1.32	22.70 ± 1.26	0.008*	19.38 ± 1.32	20.49 ± 1.45	0.0001*	21.24 ± 1.74	21.06 ± 1.62	0.64
LAM-M	26.67 ± 1.58	27.43 ± 1.44	0.013*	24.44 ± 1.48	25.87 ± 1.46	0.0001*	26.43 ± 1.88	26.11 ± 1.79	0.45

*Significant, **High Significant

Table 4. Comparison of Right and Left Side Transverse Measurements for Maxillary and Mandibular Dental and Alveolar Arches in Angle Class I Normal Occlusion, Angle class II Division 1,Angle class II subdivision

The comparison of right and left sides for each parameter is reported as follows, as shown in Table 4: -

Angle Class I Normal Occlusion: Significant differences were found between the right and left sides for LC-M (p = 0.027), LP-M (p = 0.004), LM-M (p = 0.004), and LAP-M (p = 0.008).

Angle Class II Division 1: Statistically significant differences were observed for UC-M (p = 0.012), UP-M (p = 0.046), UM-M (p = 0.025), LC-M (p = 0.0001), LP-M (p = 0.0001), LM-M (p = 0.001), LAP-M (p = 0.0001), and LAM-M (p = 0.0001).

Angle Class II Subdivision: Significant asymmetries were present for UAC-M (p = 0.0001), UAP-M (p = 0.013), LAC-M (p = 0.031), and LAP-M (p = 0.64).

Summarizing Table 4, Angle Class II Division 1 and Class II subdivision malocclusions show more intra-arch asymmetries compared to Class I normal occlusion, with a tendency toward greater discrepancies in lateral parameters on both sides.

Comparison of Right and Left Side Tooth Material (M-D Width) in Angle Class I Normal Occlusion, Class II Division 1, and Class II Subdivision :-

The analysis of intra-arch symmetry for the parameter distances between teeth 1 and 6 on the right and left sides in Angle Class I normal occlusion, Angle Class II Division 1, and Angle Class II subdivision malocclusions.

Parameters	**Angle Class I Normal Occlusion**			**Angle class II Division 1**			**Angle class II Subdivision**		
	Right side	Left side	**p Value**	**Right side**	**Left side**	**p Value**	**Right side**	**Left side**	**p Value**
	Mean ± SD (n=50)	Mean ± SD (n=50)		**Mean ± SD (n=50)**	**Mean ± SD (n=50)**		**Mean ± SD (n=40)**	**Mean ± SD (n=40)**	

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Upper 1-6	48.01 ± 1.86	48.31 ± 1.73	0.41	48.60 ± 1.93	48.77 ± 2.05	0.68	48.99 ± 1.96	49.23 ± 1.93	0.59
Lower 1-6	44.18 ± 1.50	44.11 ± 1.44	0.81	44.62 ± 1.91	44.75 ± 1.94	0.74	45 ± 1.52	44.95 ± 1.68	0.89

*Significant, **High Significant

Table 5 : Comparison of Right and Left Side Tooth Material (M-D Width) in Angle Class I Normal Occlusion, Class II Division 1, and Class II Subdivision

The analysis shows the following results, shown in Table 5:-

Angle Class I Normal Occlusion: No significant difference between the right and left sides for Upper 1-6 (p = 0.41) and Lower 1-6 (p = 0.81).

Angle Class II Division 1: No significant asymmetry between the right and left sides for Upper 1-6 (p = 0.68) and Lower 1-6 (p = 0.74).

Angle Class II Subdivision: No statistically significant difference between the right and left sides for Upper 1-6 (p = 0.59) and Lower 1-6 (p = 0.89).

Summarizing Table 5, no significant asymmetries were observed in the arch perimeter across all malocclusion classes, indicating relatively symmetrical upper and lower inter-arch measurements for this parameter.

Comparison of Right and Left Side Anterio-posterior measurements in Angle Class I Normal Occlusion, Class II Division 1, and Class II Subdivision :-

The study analysed inter-arch asymmetry in alveolar lengths (AL) on the right and left sides.

Parameters	Angle Class I Normal Occlusion			Angle class II Division 1			Angle class II Subdivision		
	Right side	Left side	p Value	Right side	Left side	p Value	Right side	Left side	p Value
	Mean ± SD (n=50)	Mean ± SD (n=50)		Mean ± SD (n=50)	Mean ± SD (n=50)		Mean ± SD (n=40)	Mean ± SD (n=40)	
UC- AL	9.52 ± 1.21	9.33 ± 1.70	0.52	12.04 ±1.89	11.37 ±1.63	0.06	11.30 ± 2.21	9.91 ±2.49	0.01*
UPM-AL	16.23±2.13	16.25 ± 2.10	0.96	19.82±1.94	19.44 ±1.79	0.31	18.02±3.28	17.30±2.98	0.30

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UM-AL	27.22±3.48	27.23±3.26	0.99	31.32±2.33	30.71±2.19	0.18	29.40 ±2.77	28.71±2.80	0.27
LC- AL	6.01± 0.92	6.04 ± 0.99	0.88	7.18 ± 1.44	7.44 ± 1.12	0.32	5.88 ± 1.58	7.84 ± 2.05	0.0001**
LPM-AL	12.16 ± 1.66	11.98±1.68	0.59	12.76 ± 1.76	13.04±1.46	0.39	11.88 ± 1.60	14.58±2.06	0.0001**
LM-AL	25.58±4.02	25.42±4.11	0.84	26.97 ±2.47	27.12±2.39	0.76	26.03 ±2.61	28.86±2.79	0.0001**

*Significant, **High Significant

Table 6: Comparison of Right and Left Side Anterio-posterior measurements in Angle Class I Normal Occlusion, Class II Division 1, and Class II Subdivision

The study analysed inter-arch asymmetry in alveolar lengths (AL) on the right and left sides for Angle Class I normal occlusion, Angle Class II Division 1, and Angle Class II subdivision malocclusions, with the following findings as shown in Table 6:-

- **Angle Class I Normal Occlusion:** No significant differences between right and left sides for any parameter, including UC-AL (p = 0.52), UPM-AL (p = 0.96), UM-AL (p = 0.99), LC-AL (p = 0.88), LPM-AL (p = 0.59), and LM-AL (p = 0.84).

- **Angle Class II Division 1:** No significant asymmetry observed between right and left sides for any parameter, with UC-AL (p = 0.06), UPM-AL (p = 0.31), UM-AL (p = 0.18), LC-AL (p = 0.32), LPM-AL (p = 0.39), and LM-AL (p = 0.76).

- **Angle Class II Subdivision:** Statistically significant differences were observed between right and left sides for UC-AL (p = 0.01), LC-AL (p = 0.0001), LPM-AL (p = 0.0001), and LM-AL (p = 0.0001), indicating notable asymmetry.

Summarizing Table 6, significant inter-arch asymmetry in alveolar lengths was detected predominantly in Angle Class II subdivision malocclusion, while Angle Class I and Class II Division 1 malocclusions displayed symmetry across these parameters.

4. Discussion

Dentoalveolar symmetry plays a crucial role in achieving optimal occlusion and aesthetics in orthodontics. The evaluation of this symmetry is essential for understanding the underlying factors contributing to various malocclusions. This study aimed to assess the degree of intra-arch dental and alveolar symmetry in the transverse and anteroposterior planes among subjects with Angle's Class I normal occlusion, Class II Division 1, and Class II subdivision malocclusions.

Asymmetry can arise from a variety of factors, including genetic predisposition, functional habits, and environmental influences. Identifying whether asymmetry is predominantly dentoalveolar, skeletal, or a combination is essential for effective treatment planning. Previous literature has indicated that even individuals with normal occlusion may exhibit measurable degrees of asymmetry, emphasizing the need for thorough evaluations in orthodontic practice. [9,10]

In this study, notable differences in dentoalveolar symmetry were observed across the three malocclusion categories. In Angle's Class I normal occlusion group, results indicated no statistically significant differences in maxillary arch measurements between the right and left sides, although slight mean differences favouring the right side were noted (Table 6). Conversely, the mandibular arch displayed a significant left-side dominance in dental width measurements across all regions, suggesting inherent asymmetries may exist even in classically defined normal occlusion. This finding aligns with Tancan Uysal et al. in 2017, who reported similar results, indicating that the perception of normal occlusion may overlook subtle asymmetries.[11]

In the Class II Division 1 malocclusion group, statistically significant dental arch asymmetry was found in the maxillary region, with the right side being wider in the canine, premolar, and molar regions (Table 6). Interestingly, while the dental widths were asymmetrical, the alveolar widths remained statistically symmetrical, indicating that dental positioning may be influenced by factors such as tooth migration or positional changes rather than overall arch morphology (Table 4). The pronounced asymmetry in the mandibular arch suggests a more complex interplay between dental and skeletal elements in this malocclusion type [12].

Regarding the Class II subdivision malocclusion group, findings revealed symmetrical maxillary arches despite differences in molar relationships. However, significant differences in mandibular arch widths were observed, with the Class II side being wider in the canine and premolar regions (Table 6). This suggests that the position of the canines plays a critical role in overall arch width and positioning in this malocclusion type. The significant distal positioning of the lower molars further contributes to the observed asymmetries, reinforcing the hypothesis that dentoalveolar components drive the characteristics of Class II subdivision malocclusions [13,14].

Understanding the nuances of dentoalveolar symmetry across different malocclusions provides valuable insights for clinicians. The inherent asymmetries observed in Class I normal occlusion underline the necessity of individualized treatment planning, even when starting with a seemingly normal occlusion. In Class II Division 1, addressing dental asymmetries while preserving alveolar symmetry could enhance treatment outcomes and overall patient satisfaction. For Class II subdivision cases, where pronounced asymmetries exist, targeted approaches focusing on correcting canine positioning and understanding the implications of molar positioning will be essential for achieving functional and aesthetic goals [15,16].

While this study offers significant insights, it is essential to recognize its limitations. The sample size, although adequate, may not fully represent the broader population, particularly regarding ethnic and genetic variations. Additionally, the use of dental casts, while standardized, may not account for dynamic changes in tooth position during treatment. Future studies should incorporate three-dimensional imaging techniques to provide a more comprehensive view of the dental and skeletal relationships, allowing for enhanced evaluation of symmetry and treatment planning.

5. Conclusion

This study highlights the presence and patterns of dentoalveolar asymmetries across different occlusal classifications, offering critical insights into orthodontic diagnosis and treatment planning. While Angle's Class I normal occlusion exhibited near-symmetrical maxillary arches, notable asymmetry was observed in the mandibular arch, suggesting that even clinically normal occlusions may not be perfectly symmetrical. Class II Division 1 malocclusions showed significant dental asymmetries, particularly in the maxillary arch, despite symmetrical alveolar widths—implying that dental positional changes contribute more to the asymmetry than skeletal discrepancies. In Class II subdivision cases, pronounced mandibular asymmetry was evident, particularly on the Class II side, emphasizing the role of canine and molar positions in defining arch width and occlusal relationships.

These findings underscore the importance of individualized assessment of dental and alveolar symmetry in both diagnosis and treatment planning. Recognizing and addressing asymmetries—especially in cases like Class II subdivision malocclusion—can improve the precision and efficacy of orthodontic interventions. Future research incorporating larger and more diverse samples, along with advanced three-dimensional imaging, will further refine our understanding of the role of dentoalveolar asymmetry in malocclusion and contribute to more tailored and effective treatment strategies.

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