ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 6, Issue – 5, September - 2023, Page No. : 35 - 45

To compare of arch width, alveolar width and buccolingual inclination of teeth between Class II division 1 and Class II division 2 malocclusion.

[1]Bhawana, JR-3, Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

[2]Atul Singh, Professor and Head of the Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

[3]Omkar Singh, Reader of the Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

[4]Sunegha Kundal, Senior lecturer of the Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

[5]Jitender Kumar, JR-3, Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

[6]Diksha Singh, JR-3, Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

Corresponding Author: Bhawana, JR-3, Department of Orthodontics and Dentofacial Orthopaedic, K.D Dental College and Hospital, Uttar Pradesh, India

Citation of this Article: Bhawana, Atul Singh, Omkar Singh, Sunegha Kundal, Jitender Kumar, Diksha Singh, "To compare of arch width, alveolar width and buccolingual inclination of teeth between Class II division 1 and Class II division 2 malocclusion", IJDSIR- September - 2023, Volume – 6, Issue - 5, P. No. 35 – 45.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: To compare of arch width, alveolar width and buccolingual inclination of teeth between Class II division 1 and Class II division 2 malocclusion of 1st molar ,1st premolar,2nd premolar.

Materials and Methods: Maxillary and mandibular pretreatment dental casts of 25 patients with Class II div 1 malocclusion and 25 patients with Class II div 2 malocclusion of average age 15-20 yrs. A digital caliper used to measure the arch width and alveolar width of maxillary and mandibular 1st molar ,1st premolar,2nd premolar. Modified protractor as per the requirements of the study used to measure buccolingual inclination of maxillary and mandibular 1stmolar, 1stpremolar, 2nd premolar.

Result: The maxillary posterior teeth are significantly more lingual tilted significantly in Class II division 2 malocclusion compared with in Class II div1

malocclusion.The first mandibular premolars are less lingually tilted in Class II division 1 malocclusion than in Class II div 2 malocclusion, whereas there is difference in buccolingual inclination of mandibular second premolars and first molars between the Class II div 1 and Class II div

The arch width of the maxillary first molars and second premolars in the Class II division1 malocclusion group was slight smaller than in the Class II division 2 occlusion group, but the difference was not statistically significant.

The alveolar width of posterior teeth is not different between Class II division 1 malocclusion and Class II div 2 malocclusions.

Conclusion: Buccolingual inclination rather than arch width, alveolar width plays an important role in transverse discrepancy of Class II malocclusion.

Keywords: Class II div 1 and Class II div 2 malocclusion, buccolingual inclination, arch width, alveolar width.

Introduction

Angle defined Class II malocclusion as characterized by a distal relation of the lower to the upper permanent first molar to the extent of more than one-half the width of one cusp and the maxillary incisors being protrusive. The Class II malocclusion is a common malocclusion with a prevalence ranging between 5% and 29%. Two thirds of the patients with Class II division 1 malocclusion were reported to have an associated significant skeletal discrepancy. The dentoskeletal morphology of subjects exhibiting Class II malocclusion has been reported in several studies Some reports have indicated that the maxilla in Class II division 1 patients was more protrusive and the mandible was normal in size and position. Other studies found that the maxilla was in a normal position in relation to the cranial base while the mandible was retrusive. Others found that Class II skeletal pattern is due to both maxillary protrusion and mandibular retrusion. It seems that ethnic backgrounds of the sample used in these studies have played a role in determining the craniofacial characteristics of the Class II pattern.

Class II division 1 malocclusion is one of the most common problems in orthodontic clinical practice.In the past, orthodontists focused mostly on the sagittal relationship of Class II malocclusion. Today, more and more studies have been focused on the transverse discrepancy in Class II division 1 malocclusion, and the results have been controversial.

Andrew suggested the use of an anatomic references, such as a parameter with the object of centralizing the roots of teeth in the basal bone, which they denominated via the WALA (Will Andrew & Larry Andrew) Ridge. The WALA ridge is strip of soft tissue immediately above mucogingival junction of the mandible, at the level of the line that passes through the centres of the rotation of the teeth or close to it and is exclusive to the mandible. Therefore, the centre line of rotation (hypothetical line that passes through the horizontal centre of rotation of each tooth) would be the line those best conserves the original and ideal form of the dental arch. Researchers have identified that there was significant relationship between the dental arch form and the WALA curve both in Class I occlusion and Class II division 1 malocclusion. In these studies, the WALA ridge was also considered as the mark of mandibular alveolar basal bone Thus the ideal form of the maxillary and mandibular dental arches would be dictated by the form of the basal bone of the mandible. When the form of mandibular dental arch is correct, the wire that unites the bracket slot of “straight wire” bracket should have same shape as that of the WALA ridge. The mandibular

alveolar process is selected because its shape would be minimally effected by faciolingual tipping of the teeth, this would happen because of the shape of underlying basal bone. By taking it as a base of study i.e relation between teeth and WALA ridge, standard distances were established between FA points and the WALA ridge which would influence the treatment plan.

Thus, studies on the transverse discrepancy of Class II division malocclusion, with selected samples according to dental is required. The aim of this research is to study whether there is transverse discrepancy in Class II division 1malocclusion and Class II division 2 malocclusion and the role arch width, alveolar width, and buccolingual inclination play in such a discrepancy.

Material and Methods

Maxillary and mandibular pretreatment dental casts of 25 patients with Class II div 1 malocclusion and 25 patients with Class II div 2 attending at the OPD of Department of Orthodontics and Dentofacial Orthopaedics at the K.D. Dental college and Hospital. Pre-treatment cast of 25 samples with Class II div 1 and 25 samples of Class II div 2 malocclusion of average age 15-20 yrs.

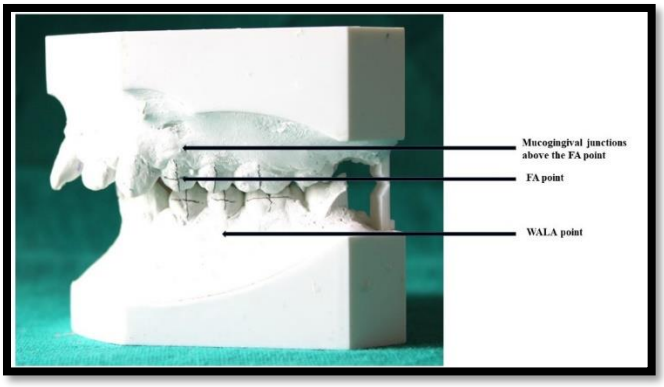


Fig.1 : Study model of class II div1

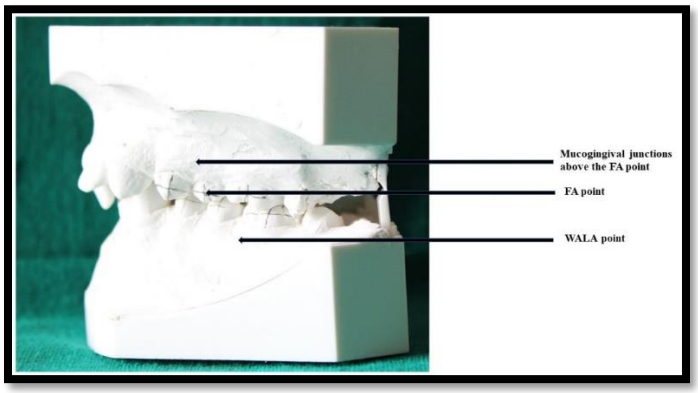


Fig. 2: Study Model of Class II Div 2

The Inclusion Criteria For Class II Div 1:

(1) The mesiobuccal cusps of maxillary first molars were mesial to the mesiobuccal groove of the corresponding mandibular first molars bilaterally.

(2) Full complement of permanent dentition with fully erupted first premolars, second premolars, and first molars.

(3) Increased overjet

(4) Class II skeletal relationship

(5) Good periodontal condition

The Inclusion Criteria For Class II Div 2:

(1) The mesiobuccal cusps of maxillary first molars were mesial to the mesiobuccal groove of the corresponding mandibular first molars bilaterally.

(2) Full complement of permanent dentition with fully erupted first premolars, second premolars, and first molars.

(3) Class II skeletal relationship

(4) Retroinclination of maxillary central incisor and overlap of lateral incisor.

(5) Deep overbite minimal overjet

(5) Good periodontal condition

The Exclusion Criteria For Class II Malocclusion (50 Sample)

(1) Patients with history of orthodontic, prosthodontic, or orthognathic treatment.

(2) Crowding > 2mm, crossbite, rotation of tooth/teeth in the arch.

(3) Occlusion with missing teeth except 3rd molar.

(4) Any abrasion or defect on the buccal surface of the premolars and first molars under the naked eye

Material Used

1. Well fabricated maxillary and mandibular casts of each individual.
2. Scale
3. Protractor for measuring angle
4. Pencil and Rubber
5. A digital caliper with minimal accuracy of 0.02 mm used to measure the arch width and alveolar width.
6. Modified protractor as per the requirements of the study used to measure buccolingual inclination.

Fig. 3: scale, pencil, eraser

Fig.4: Digital caliper

Fig.5: Modified protractor

Following Measurement Were Made

The facial axis of clinical crown (FACC) and its midpoint, the facial-axis point (FA point) point, were marked on the buccal surface as described by Andrews and were used to measure the buccolingual inclination. These measurements were taken from the trimmed casts:

- buccolingual inclination of bilateral maxillary and mandibular first molars
- buccolingual inclination of bilateral maxillary and mandibular first and second premolars.
- intermolar width between the FA point of bilateral maxillary and mandibular first molars.
- first premolar width between the FA point of bilateral maxillary and mandibular first premolars.
- second premolar width between the FA point of bilateral maxillary and mandibular second premolars.
- maxillary alveolar width between the mucogingival junctions above the FA point of bilateral first maxillary molars.
- maxillary alveolar width between the mucogingival junctions above the FA point of bilateral first and second maxillary premolars.
- mandibular alveolar width between the WALA point below the FA point of bilateral first mandibular molars.

- mandibular alveolar width between the WALA point below the FA point of bilateral first and second premolars.

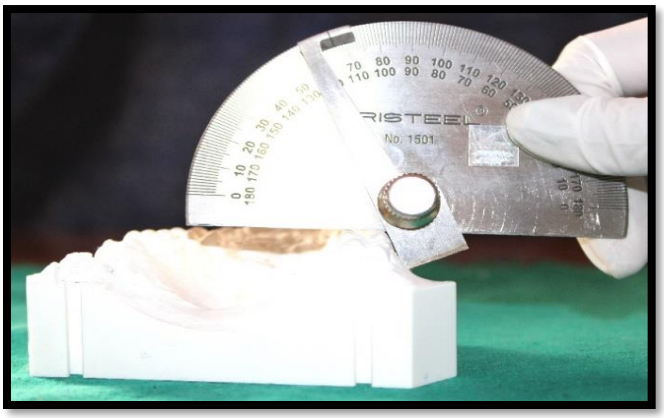


Fig. 6: Measurement of Buccolingual Inclination

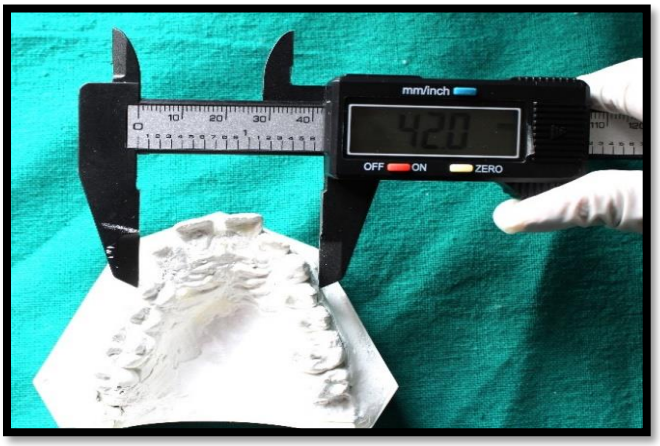


Fig. 7: Measurement of Arch Width

Fig. 8: Measurement of Alveolar arch width

Result

Twenty-five casts were randomly selected to be measured. Paired t-test was applied to determine the systematic error. The comparison showed that the differences between the first and second measurements for arch and alveolar width and buccolingual inclination were insignificant.

Table 1(a): Intergroup Comparison of Alveolar Width Between Class II Div I And Class II Div II Samples In Different Maxillary Teeth

Tooth	Inter Group	Mean	SD	Std Error	Mean Diff	T value	P value
Ist premolar	Div I	45.58	3.88	0.777	- 4.68000	- 4.328	0.001 (Sig)
	Div II	50.26	3.75	0.751			
IInd Premolar	Div I	52.41	2.46	0.493	- 2.46400	- 2.494	0.016 (Sig)
	Div II	54.87	4.28	0.856			
Ist Molar	Div I	57.78	3.42	0.684	- 2.19200	- 1.756	0.045 (Sig)
	Div II	59.96	5.22	1.043			

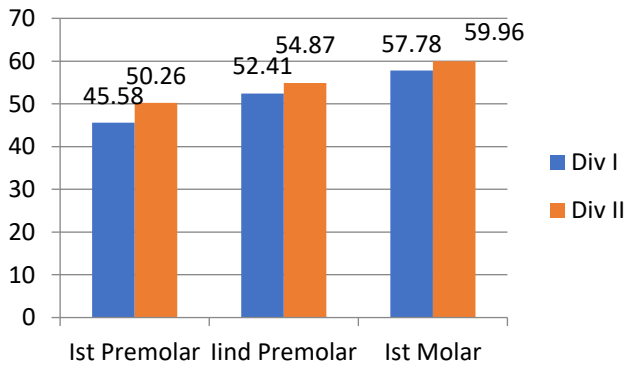


Table 1(b): Intergroup Comparison of Alveolar Width Between Class II Div I And Class II Div II Samples In Different Mandibular Teeth

Tooth	Inter Group	Mean	SD	Std Error	Mean Diff	T value	P value
Ist premolar	Div I	42.57	4.60	.921	- 1.34400	- 1.128	0.265 (Non-Sig)
	Div II	43.92	3.77	.755			
IInd Premolar	Div I	49.89	4.651	.930	1.72000	1.373	0.176 (non-Sig)
	Div II	48.17	4.194	.838			
Ist Molar	Div I	58.50	3.787	.757	1.08000	1.064	0.292 (non-Sig)
	Div II	57.42	3.375	.675			

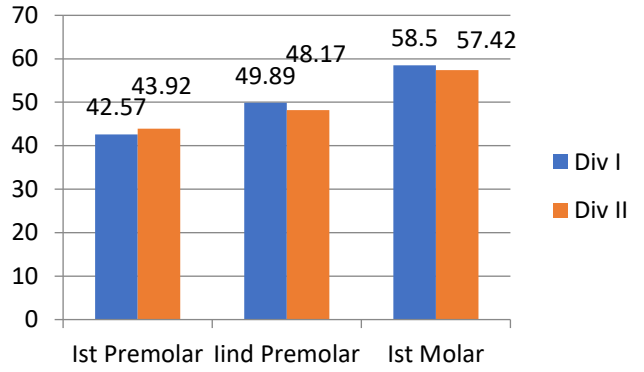


Table 2(a): Intergroup Comparison of Bucco Lingual Inclination Between Class II Div I And Class II Div II Samples in Different Maxillary Teeth

Tooth	Inter Group	Mean	SD	Std Error	Mean Diff	T value	P value
Ist premolar	Div I	65.60	6.99	1.398	- 4.84000	- 3.135	0.003 (Sig)
	Div II	70.44	3.26	.653			
IInd Premolar	Div I	67.88	6.233	1.246	- 3.84000	- 2.685	0.010 (Sig)
	Div II	71.72	3.506	.701			
Ist Molar	Div I	66.88	6.869	1.373	- 7.24000	- 4.146	0.001 (Sig)
	Div II	74.12	5.387	1.077			

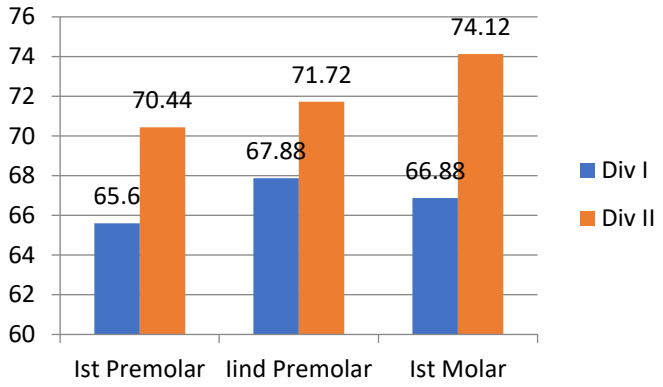


Table 2(b): Intergroup Comparison of Bucco Lingual Inclination Between Class II Div I And Class II Div II Samples In Different Mandibular Teeth

Tooth	Inter Group	Mean	SD	Std Error	Mean Diff	T value	P value
Ist premolar	Div I	68.96	5.04	1.009	1.08000	.874	0.386 (non-Sig)
	Div II	67.88	3.56	.712			
IInd Premolar	Div I	68.60	4.102	.820	.76000	.621	0.538 (non-Sig)
	Div II	67.84	4.543	.908			
Ist Molar	Div I	66.28	7.797	1.559	- 3.20000	- 1.606	0.115 (non-Sig)
	Div II	69.48	6.198	1.239			

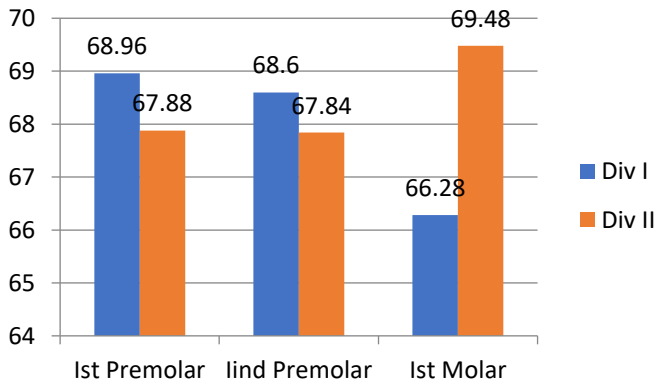


Table 3(a): Intergroup Comparison of Arch Width Between Class II Div I And Class II Div II Samples In Different Maxillary Teeth

Tooth	Inter Group	Mean	SD	Std Error	Mean Diff	T value	P value
Ist premolar	Div I	43.89	2.13	.426	.58000	.988	0.328 (non-Sig)
	Div II	43.31	2.02	.403			
IInd Premolar	Div I	48.21	3.048	.609	-.66800	-.606	0.548 (non-Sig)
	Div II	48.88	4.596	.919			
Ist Molar	Div I	54.46	1.777	.355	.69200	1.112	0.272 (non-Sig)
	Div II	53.77	2.555	.511			

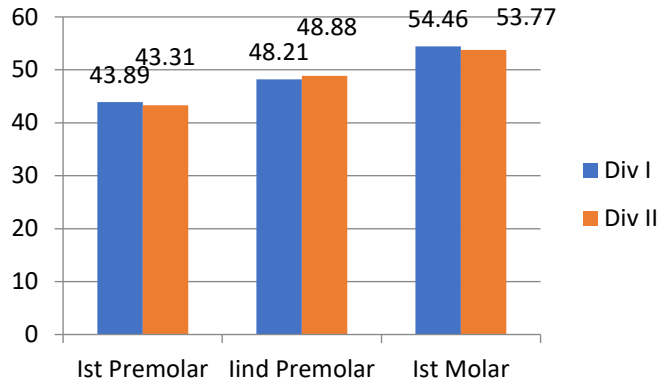
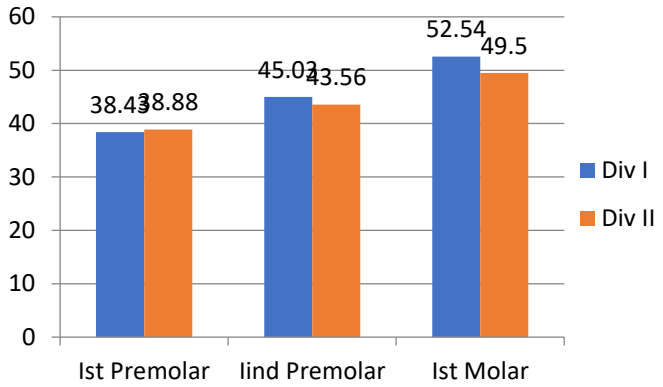


Table 3(b): Intergroup Comparison of Arch Width Between Class II Div I And Class II Div II Samples In Different Mandibular Teeth

Tooth	Inter Group	Mean	SD	Std Error	Mean Diff	T value	P value
Ist premolar	Div I	38.43	2.49	.498	-.44800	-.551	0.584 (non-Sig)
	Div II	38.88	3.21	.642			
IInd Premolar	Div I	45.03	2.530	.506	1.47200	1.965	0.095 (non-Sig)
	Div II	43.56	2.761	.552			
Ist Molar	Div I	52.54	3.796	.759	3.04400	3.441	0.055 (non-Sig)
	Div II	49.50	2.269	.453			



Discussion

A thorough knowledge of the skeletal and dental components that contribute to a malocclusion is essential as these elements may influence the treatment approach. Angle defined Class II malocclusion as characterized by a distal relation of the lower to the upper permanent first molar to the extent of more than one-half the width of one cusp and the maxillary incisors being protrusive[1]. The Class II malocclusion is a common malocclusion with a prevalence ranging between 5% and 29% . Two thirds of the patients with Class II division 1 malocclusion were reported to have an associated significant skeletal discrepancy[3]. The dentoskeletal morphology of subjects exhibiting Class II malocclusion has been reported in several studies.

A literature review showed that only Frohlich's study[14] supported our results. Even in studies that agreed that Class II division 1 malocclusion has a narrower maxillary arch, there are some contradictions. The research of Uysal et al demonstrated a narrower interpremolar width but wider maxillary intermolar width in a Class II division 1 patient, while the Sayin and Turkkanhraman result was just the opposite. They found the Class II division 1 group with narrower maxillary intermolar width and interpremolar width, but no narrower interpremolar width. It seems that the result of arch width difference may be influenced easily by both sample size and sample selection. According to our

results, lingually tilted maxillary posterior teeth may induce a narrow arch width. There was a tendency for Class II division 1 malocclusion to have a narrower maxillary arch in our result, but the difference was not statistically significant.

From the orthodontic point of view, the degree of the reduction tendency of the maxillary molar is perhaps expressed as a shorter distance between the bracket base and the slot on the mesial than the distal half of the molar, or the distal offset prescription of the SWA system. Because the reduction tendency was originally based on the cusp tip position, its application to the bracket prescription is not perfectly pertinent. The buccolingual dimensions of the tooth are known to be established far later during development than the cusp position, which mainly depends on the formation of enamel knots. Therefore, the Buccolingual outline is reported to be independent of the cusp position. In this respect, the measurements on the outermost points of the 4 cusps were inserted as raw data for cluster analysis in this study, since these points are where the bracket or tube base is bonded. However, the angle between the midsagittal line and the buccal cusp line is not so different from the angle between the midsagittal line and the buccal vertex line.

We concluded that, rather than arch width, the buccolingual inclination played a major role in transverse discrepancy in Class II malocclusion.

Conclusion

Our study was carried out to compare the arch width, alveolar width, and Buccolingual inclination of maxillary and mandibular posterior teeth between Class II division 1 malocclusion and Class II div 2 malocclusions. A total sample size of 25 subjects of Class II div1 malocclusion and 25 subjects with Class II division 2 malocclusion

Following conclusion is drawn from the study.

The maxillary posterior teeth are significantly more lingual tilted significantly in Class II division 2 malocclusion compared with in Class II div1 malocclusion.

The first mandibular premolars are less lingually tilted in Class II division 1 malocclusion than in Class II div 2 malocclusions, whereas there is difference in buccolingual inclination of mandibular second premolars and first molars between the Class II div 1 and Class II div 2.

The arch width of the maxillary first molars and second premolars in the Class II division1 malocclusion group was slight smaller than in the Class II division 2 occlusion group, but the difference was not statistically significant.

The alveolar width of posterior teeth is not different between Class II division 1 malocclusion and Class II div 2 malocclusions.

The buccolingual inclination plays a more important role in transverse discrepancy of Class II malocclusion .

References

1. Massler M, Frankel JM. Prevalence of malocclusion in children aged 14 to 18 years. American journal of orthodontics. 1951 Oct 1;37(10):751-68.
2. Moyers RE, Riolo ML, Guire KE, Wainright RL, Bookstein FL. Differential diagnosis of Class II malocclusions: Part 1. Facial types associated with Class II malocclusions. American journal of orthodontics. 1980 Nov 1;78(5):477-94.
3. Mcnamara JR JA. Components of Class II malocclusion in children 8-10 years of age. The Angle orthodontist. 1981 Jul;51(3):177-202.
4. Pancherz H, Zieber K, Hoyer B. Cephalometric characteristics of Class II division 1 and Class II

division 2 malocclusions: a comparative study in children. The Angle orthodontist. 1997 Apr;67(2):111-20.

5. Lauc T. Orofacial analysis on the Adriatic islands: an epidemiological study of malocclusions on Hvar Island. Eur J Orthod. 2003;25:273–278.
6. 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;74:356–360.
7. Staley RN, Stuntz WR, Peterson LC. A comparison of arch widths in adults with normal occlusion and adults with Class II, division 1 malocclusion. Am J Orthod. 1985;88:163–169.
8. Tollaro I, Baccetti T, Franchi L, Tanasescu CD. Role of posterior transverse interarch discrepancy in Class II, division 1 malocclusion during the mixed dentition phase. Am J Orthod Dentofacial Orthop. 1996;110:417–422.
9. 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. The Angle Orthodontist. 2004 Jun;74(3):356-60.
10. Frohlich F. A longitudinal study of untreated Class II type malocclusion. Trans Eur Orthod Soc. 1961;37:137–139.
11. Ball RL, Miner RM, Will LA, Arai K. Comparison of dental and apical base arch forms in Class II division 1 and Class I malocclusions. Am J Orthod Dentofacial Orthop. 2010;138: 41–50.
12. Gupta D, Miner RM, Arai K, Will LA. Comparison of the mandibular dental and basal arch forms in adults and children with Class I and Class II malocclusions. Am J Orthod Dentofacial Orthop. 2010;138:10 e11–e18; discussion 10– 11.
13. Andrews LF. The six elements of orofacial harmony. Andrews J. J Orthod Orofacial Harmony. 2000;1:13–22.
14. Ronay V, Miner RM, Will LA, Arai K. Mandibular arch form: the relationship between dental and basal anatomy. American Journal of Orthodontics and Dentofacial Orthopedics. 2008 Sep 30;134(3):430-8.
15. Wong CA, Sinclair PM, Keim RG, Kennedy DB. Arch dimension changes from successful slow maxillary expansion of unilateral posterior crossbite. The Angle Orthodontist. 2011 Feb 9;81(4):616-23.
16. Bishara SE, Ortho D, Jakobsen JR, Treder J, Nowak A. Arch width changes from 6 weeks to 45 years of age. American Journal of Orthodontics and Dentofacial Orthopedics. 1997 Apr 30;111(4):401-9.
17. Cassidy KM, Harris EF, Tolley EA, Keim RG. Genetic influence on dental arch form in orthodontic patients. The Angle orthodontist. 1998 Oct;68(5):445-54.
18. Bishara SE, Jakobsen JR, Treder J, Nowak A. Arch length changes from 6 weeks to 45 years. The Angle orthodontist. 1998 Feb;68(1):69-74.
19. Braun S, Hnat WP, Fender DE, Legan HL. The form of the human dental arch. The Angle Orthodontist. 1998 Feb;68(1):29-36.
20. Burris BG, Harris EF. Maxillary arch size and shape in American blacks and whites. The Angle Orthodontist. 2000 Aug;70(4):297-302.
21. Hassan N, Tahereh H, Reza S. The dental arch form revisited. Angle orthod. 2001;71(5):386
22. Hassan N, Tahereh H, Reza S. The dental arch form revisited. Angle orthod. 2001;71(5):386

23. Zilberman O, Huggare J, Parikakis KA. Evaluation of the validity of tooth size and arch width measurements using conventional and three-dimensional virtual orthodontic models. The Angle orthodontist. 2003 Jun;73(3):301-6.
24. Tollaro I, Baccetti T, Franchi L, Tanasescu CD. Role of posterior transverse interarch discrepancy in Class II, division 1 malocclusion during the mixed dentition phase. Am J Orthod Dentofacial Orthop. 1996;110:417–422.
25. Šlaj M, Ježina MA, Lauc T, Rajic-Meštrovic S, Mikšic M. Longitudinal dental arch changes in the mixed dentition. The Angle orthodontist. 2003 Sep;73(5):509-14.
26. McNamara Jr JA, Baccetti T, Franchi L, Herberger TA. Rapid maxillary expansion followed by fixed appliances: a long-term evaluation of changes in arch dimensions. The Angle orthodontist. 2003 Aug;73(4):344-53.
27. Lux CJ, Conradt C, Burden D, Komposch G. Dental arch widths and mandibular-maxillary base widths in Class II malocclusions between early mixed and permanent dentitions. The Angle Orthodontist. 2003 Dec;73(6):674-85.
28. Janson G, Bombonatti R, Cruz KS, Hassunuma CY, Del Santo M. Buccolingual inclinations of posterior teeth in subjects with different facial patterns. American journal of orthodontics and dentofacial orthopedics. 2004 Mar 31;125(3):316-22.
29. Işık F, Sayınsu K, Nalbantgil D, Arun T. A comparative study of dental arch widths: extraction and non-extraction treatment. The European Journal of Orthodontics. 2005 Dec 1;27(6):585-9.
30. Aksu M, Kocadereli I. Arch width changes in extraction and nonextraction treatment in Class I patients. The Angle Orthodontist. 2005 Nov;75(6):948-52.
31. 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. The Angle Orthodontist. 2005 Nov;75(6):941-7.
32. Al-Khateeb SN, Abu Alhaija ES. Tooth size discrepancies and arch parameters among different malocclusions in a Jordanian sample. The Angle Orthodontist. 2006 May;76(3):459-65.
33. Ward DE, Workman J, Brown R, Richmond S. Changes in arch width: a 20-year longitudinal study of orthodontic treatment. The Angle orthodontist. 2006 Jan;76(1):6-13.
34. Cozzani M, Guiducci A, Mirenghi S, Mutinelli S, Siciliani G. Arch width changes with a rapid maxillary expansion appliance anchored to the primary teeth. The Angle orthodontist. 2007 Mar;77(2):296-302.
35. Anderson AA. The dentition and occlusal development in children of African American Descent: Biometrics of the primary dentition. The Angle Orthodontist. 2007 May;77(3):421-9.
36. Ronay V, Miner RM, Will LA, Arai K. Mandibular arch form: the relationship between dental and basal anatomy. American Journal of Orthodontics and Dentofacial Orthopedics. 2008 Sep 30;134(3):430-8.
37. Kuntz TR, Staley RN, Bigelow HF, Kremenak CR, Kohout FJ, Jakobsen JR. Arch widths in adults with Class I crowded and Class III malocclusions compared with normal occlusions. The Angle orthodontist. 2008 Jul;78(4):597-603.
38. Da Silva Filho OG, Ferrari Júnior FM, Okada Ozawa T. Dental arch dimensions in Class II division 1 malocclusions with mandibular

deficiency. The Angle Orthodontist. 2008 May;78(3):466-74.

39. Ling JY, Wong RW. Dental arch widths of Southern Chinese. The Angle Orthodontist. 2009 Jan;79(1):54-63.
40. Ball RL, Miner RM, Will LA, Arai K. Comparison of dental and apical base arch forms in Class II Division 1 and Class I malocclusions. American Journal of Orthodontics and Dentofacial Orthopedics. 2010 Jul 31;138(1):41-50.
41. Slaj M, Spalj S, Pavlin D, Illes D, Slaj M. Dental archforms in dentoalveolar Class I, II and III. The Angle Orthodontist. 2010 Sep;80(5):919-24.
42. Ru N, Liu SS, Zhuang L, Li S, Bai Y. In vivo microcomputed tomography evaluation of rat alveolar bone and root resorption during orthodontic tooth movement. The Angle Orthodontist. 2012 Oct 3;83(3):402-9.
43. Shu R, Han X, Wang Y, Xu H, Ai D, Wang L, Wu Y, Bai D. Comparison of arch width, alveolar width and buccolingual inclination of teeth between Class II division 1 malocclusion and Class I occlusion. The Angle orthodontist. 2012 Sep 4;83(2):246-52.
44. Gianelly AA. Arch width after extraction and nonextraction treatment. American journal of orthodontics and dentofacial orthopedics. 2003 Jan 31;123(1):25-8.
45. Zhang K, Huang L, Yang L, Xu L, Xue C, Xiang Z, Zhao M, Li S, Bai Y, Bai D. Effects of transverse relationships between maxillary arch, mouth, and face on smile esthetics. The Angle Orthodontist. 2015 Apr 29;86(1):135-41.
46. Cao L, Zhang K, Bai D, Jing Y, Tian Y, Guo Y. Effect of maxillary incisor labiolingual inclination and anteroposteriorposition on on smiling profile esthetics. Angle Orthod. 2011;81: 121–129.