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RESEARCH ARTICLE

LATERAL CEPHALOMETRIC DIAGNOSIS OF ASYMMETRY IN DIFFERENT TYPES OF SKELETAL MALOCLUSSION

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ABSTRACT

Introduction: Asymmetry when applied to facial morphology refers to the correspondence difference in the size, shape and location of facial landmarks on opposite sides of the median sagittal plane. Malocclusion cases with their asymmetric occlusal relationships often cause treatment difficulties. The nature of occlusal asymmetry may be due to dentoalveolar or skeletal asymmetries, or due to a combination of both these factors and these underlying factors complicate the attainment of a symmetric occlusion. **Objective**: The objective of the study was to use lateral cephalometric radiographs to evaluate skeletal and dental asymmetries in Class I, Class II and Class III malocclusions. **Materials and Method**: Seventy -four initial lateral cephalometric radiographs were randomly divided into three groups: Group I (30 Class I lateral cephalometric radiographs), Group II (30 Class II lateral cephalometric radiographs) and Group III (14 Class III lateral cephalometric radiographs). Analysis of lateral cephalometric radiographs included angular measurements, horizontal linear measurements and two indexes of asymmetry that were prepared for the study. **Result**: To test the hypothesis that the mean angular measurements were equivalent for the three groups an analysis of variance (ANOVA) was used and statistically significant correlation was found($p<0.05$).A chi-square test was used to test the proportion of individuals and dental symmetry was more statistically significant in Group1 and Group2 than in Group 3. **Conclusion**: Dental and skeletal asymmetry was found to be greater in Skeletal Class III and Skeletal Class II malocclusion than Skeletal class I malocclusion.

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INTRODUCTION

The general approach to diagnosis and treatment planning is the same for patients with asymmetry as for those with other deformities but with greater emphasis on full face rather than profile evaluation. Careful clinical examination of facial proportions in all the 3 planes of space is important and photographic records should include three-quarter as well as full face and profile views of the face. In the lateral cephalometric radiographs, vertical asymmetries often can be recognised by the failure of bilaterally symmetric structures to superimpose as they normally do since only one side is usually traced, this indication of asymmetry is easy to miss when tracings receive more attention than the radiograph itself. The appearance of asymmetry in lateral cephalometric radiographs can also be created or concealed by improper head positioning (Profitt, Sarver, 2002). The nature of the occlusal asymmetry may be due to dentoalveolar or skeletal asymmetries or combination of these factors, and it is thought that these underlying factors complicate the attainment of a symmetric occlusion (Alavi, 1988). Considering the discrepancy in size or shape of the two halves or anatomical morphology of the mandible, subjects with mandibular deviation particular those with Class III malocclusion often present with differences in the hemi mandibular volume, mandibular body length, ramal volume, mandibular body length, ramal volume, condylar length, condylar volume, and ramus inclination between the contralateral side of deviation and deviated sides. Because of such asymmetric deformity, so called dental compensations, such as dental asymmetry, slanting of the occlusion plane, and unilateral crossbite, are commonly observed. Slight degrees of facial asymmetry are common among the general population (De-Hua Zheng, 2017). Asymmetry resulted from dentoalveolar involvement without observable changes in the jaw. Study models may be used for observation of dental structures in the anteroposterior direction, but these models do not allow skeletal observations. In addition, panoramic radiographs do not enable anteroposterior morphological alterations to be visualized. Because they are traditionally required for orthodontic treatment, lateral cephalometric

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radiographs allow visualization of anteroposterior structures in a simple manner without additional costs to the orthodentist (Aparecida Fernanda, 2014). So the purpose of this study is to use lateral cephalometric diagnosis of asymmetry in different types of skeletal malocclusion.

MATERIALS AND METHODS

The study was conducted on individuals in the department of Orthodontics Himachal Dental College Sundernagar. The sample was divided into 3 equal groups as Class I, Class II, Class III patients.

Selection Criteria

- Normal lower arch
- Lower arch with mild anterior crowding
- Presence of all permanent teeth
- With eminent eruption of second molars in the arch

Exclusion Criteria

- Presence of any occlusal interference that might cause functional alterations
- Presence of cross bite
- History of any dental trauma

For characterization of the sample, the following angular measurements were used: (Fig 1)

- **SNA**- It is the angle formed between SN plane and the line joining point N and point A
- **SNB**- It is the angle formed between SN plane and the line joining point N and point
- **ANB**- It is the angle between two lines joining point AN and NB
- **SN.PP**- It is the angle formed between SN plane and the palatal plane
- **SN .OP**- It is the angle formed between SN plane and the occlusal plane
- **U1.SN**- It is the angle formed between the long axis passing through the upper central incisor and the SN plane
- **L1.GoMe**- It is the angle formed between the long axis passing through the lower central incisor and the line joining gonion and menton
- **NA.Pog**- It is the angle formed between the lines connecting point N and point A and the line connecting point Pog and N.

Study analysis involved two indexes (i.e., the index of dental asymmetry and the index of mandibular asymmetry) as well as five linear measurements (RA-RP, D7UA-D7UP, D6UA-D6UP, D7LA-D7LP and D6LA-D6LP) (Aparecida Fernanda, 2014). (Fig 2)

Index of dental asymmetry: An IDA was developed based on the difference in distance between the most anterior and the most posterior molars in the upper and lower dental arches [IDA1 = (D6UA-D6UP) – (D6LA-D6LP)]. Similarly, this index was applied for second upper and lower molars [IDA2= (D7UA-D7UP) – (D7LA-D7LP)]. Mathematically, a difference of zero represents upper-lower dental symmetry.

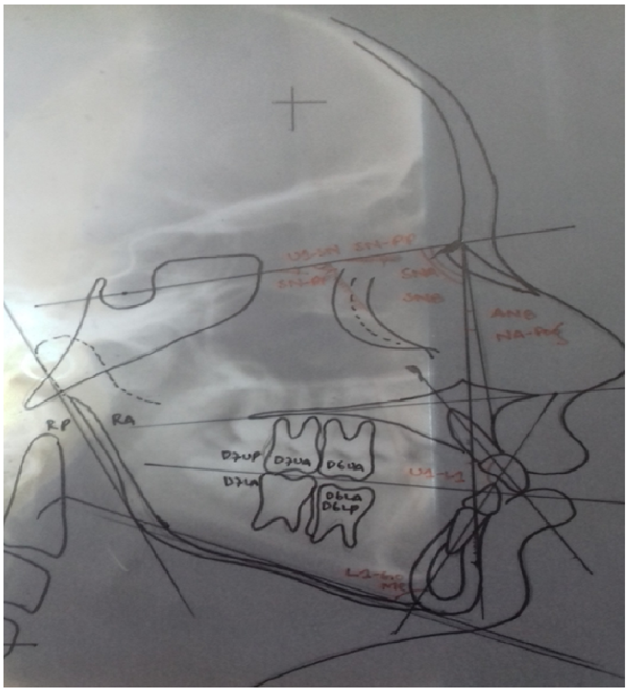

Fig. 1. Showing all the Angular Measurements

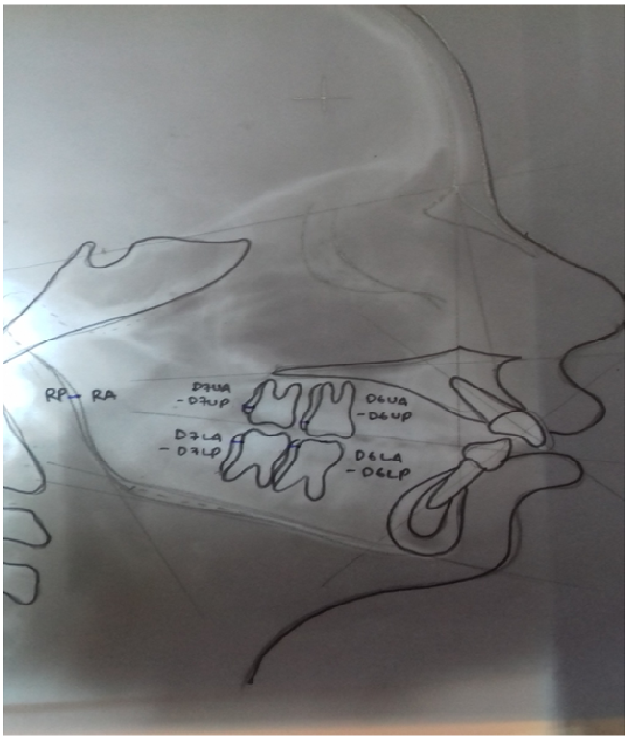

Fig. 2. Showing all the Linear Measurements

For example, the IDA using the first molars is described as follows:

» IDA1= (D6UA-D6UP) – (D6LA-D6LP), where

»(D6UA-D6UP) = distance between the most anterior image of the upper first molar (D6UA) and the most posterior molar (D6UP)

»(D6LA-D6LP) = distance between the most anterior image of the lower first molar (D6LA) and the most posterior molar (D6LP).

If:

» IDA > 0.5 mm = upper dental asymmetry;
» IDA < -0.5 mm = lower dental asymmetry;
» -0.5 mm ≥ IDA ≤ 0.5 mm = upper and lower dental

Index of mandibular asymmetry: Following the same logic, an IMA was developed based on the difference in distance between the most anterior and the most posterior portions of the mandibular ramus, and the distance between the most anterior and the most posterior lower first molars [IMA1 = (RA-RP) – (D6LA-D6LP)]. Similarly, this index was applied for second molars [IMA2= (RA-RP) – (D7LA-D7LP)]. For example, the IMA using the first molars was described as follows:

» IMA1= (RA-RP) – (D6LA-D6LP), where
» (RA-RP) = distance between the most anterior image of the mandibular ramus (RA) and the most posterior one (RP); and
» (D6LA-D6LP) = distance between the most anterior image of the lower first molar (D6LA) and the most posterior one (D6LP).

If:

» IMA > 0.5 = mandibular skeletal asymmetry;
» IMA < -0.5 = mandibular dental asymmetry;
» -0.5 mm ≥ IMA ≤ 0.5 mm = skeletal and dental[4]

Statistical Analysis: To test the hypothesis mean angular measurements were equivalent for the three groups an analysis of variance (ANOVA) was used. A chi-square test was used to test the hypothesis that the proportion of subjects with asymmetries did not differ between groups and to determine whether there was an association between category of asymmetry and group. Statistical analyses were performed using SPSS software version 16.0 for Windows

RESULTS

The present study was to use lateral cephalometeric radiogarphs to identify skeletal and dental asymmetry in different types of malocclusions. The statistical analysis used to test the hypothesis mean angular measurements were equivalent for the three groups using ANOVA analysis as shown in Table1. The angular measurements ;SNA, SNB, ANB, SN-PP, U1-SN, L1-GoMe, U1-L1, NA-Pog showed statistically significant correlation($p<0.05$).The skeletal and dental linear measurements ; D6UA-D6UP, D7UA-D7UP, D6LA-D6LP, D7LA-D7LP showed statistically significant correlation ($p<0.05$). Table 2 showed the number and proportion of individuals according to group and category of the index of asymmetry and results of chi-square test for the association between asymmetry and group showed statistically significant correlation ($p<0.05$). The proportion of individuals with dental symmetry was significantly greater in Group1 and Group2 than in Group 3. Table 3 showed the descriptive statistics of the index of asymmetry and the results of ANOVA to test the hypothesis of equality of the means of the three groups according to the category of asymmetry. In IMA1 and IMA2 (dental asymmetry group) showed statistically significant correlations ($p<0.05$).

DISCUSSION

Class I malocclusion is also known as neutrocclusion where the molars are in normal class I relationship, it can have two forms Class I malocclusion and bimaxillary protrusion. The skeletal features of Class I malocclusion mainly include prognathic jaws, increased ANB angle, convex profile. The dental features include bimaxillary proclination, increased incisal angle, spacing between the teeth and steep mandibular plane angles. We can assess asymmetry in Class I malocclusion by various methods. In case of crowding in Class I malocclusion we can analyze the space discrepancy using various model analysis. We can also evaluate condylar asymmetry, ramus asymmetry, condylar plus ramus asymmetry in Class I malocclusion by using panoramic imaging. Besides this vertical mandibular asymmetry and gonial angle can also be calculated by panoramic imaging in Class I malocclusion cases. Submentovertex radiographs also help us to analyse asymmetry in cases of Class I malocclusion.

Class II malocclusion is reported as the most frequently seen skeletal disharmony in orthodontic population. Transverse component in Class II patients is of great importance as authors evaluating transverse dimensions had reported that maxillary arch is narrower in patients with Class II division1 malocclusion and an expansion was needed during or before treatment. The deficient transversal growth of the maxilla and the sagittal growth of the mandible appeared to cause the typical Class II occlusion. Patients with Class II malocclusions had a significantly narrower maxillary area during the mixed dentition phase. Patients with Class II division 1 malocclusion has a narrower maxillary intercanine, intermolar, and alveolar width and these findings revealed a posterior crossbite tendency in the Class II malocclusion. Class II Subdivision malocclusions are unique in that they display characteristics of both Class I and Class II malocclusions within the same patient.[6]

By the use of submentovertex, posteroanterior, and corrected oblique cephalometric radiographs asymmetry can be assessed. In the submentovertex radiographs, asymmetry can be assessed by measuring the relative differences in the spatial positions of dental and skeletal landmarks between the right and the left sides in both anteroposterior and transverse dimension (Aparecida Fernanda, 2014). Mandibular deviation is more frequently found in patients of skeletal Class III, which results from the excessive mandibular growth in the case of mandibular prognathism or a rotational and deviated position of the mandible.Considering the discrepancy in size or shape of the two halves or anatomical morphology of the mandible,subjects with mandibular deviation particular those with Class III malocclusion. Therefore, subjects with mandibular deviation reportedly had asymmetric deformity of not only the hard tissue structures but also of the soft tissues when comparing the left and right sides (De-Hua Zheng, 2017). The purpose of our study was to assess the asymmetry from lateral cephalograms in Class I, ClassII and Class III malocclusions. In this study ramul asymmetry, mandibular asymmetry and dental asymmetry was analysed and compared in skeletal Class I Class II and Class III malocclusions. Lateral cephalometric radiographs allow anteroposterior structures to be visualized in a simple manner and it consists of a head-holding device, consisting of an ear rod and nasal positioned which minimizes the projection errors caused by head rotation in the vertical, transverse, and anteroposterior axes.

Table 1. Mean and standard deviation of measurements and analysis of variance (ANOVA) to test the hypothesis that the means of the three groups are the same

Variables	Group I	GROUP II	GROUP III	
	Mean ±S.D	Mean ±S.D	Mean ±S.D	P
SNA	81.5±2.44	82.96±2.61	77.71±5.01	.00001**
SNB	79.06±2.47	76.36±2.41	82.78±5.35	.00001**
ANB	2.43±1.07	6.53±1.33	5.07±1.81	.00001**
SN-PP	8.26±2.37	6.3±2.42	8.35±3.79	0.01*
SN-OP	21.33±3.58	19.8±4.12	20.35±5.78	0.38
SN-GoMe	37.33±4.70	36.96±4.52	39.14±7.33	0.42
U1-SN	110.46±6.86	108.16±6.03	114.64±4.43	0.007*
L1-GoMe	88.8±4.88	97.83±8.29	82.5±9.25	.00001**
U1-L1	119.66±9.89	114.9±11.5	127.92±10.69	0.001*
NA-Pog	1.46±0.90	5.23±1.77	4.35±2.59	.00001**
Skeletal and dental linear				
RA-RP	1.52±0.47	1.66±0.47	1.64±0.69	0.56
D6UA-D6UP	1.05±0.68	0.5±0.71	0.21±0.42	0.02*
D7UA-D7UP	1.48±0.83	0.83±0.72	0.22±0.65	0.002*
D6LA-D6LP	0.96±0.75	1.23±0.78	1.80±0.50	0.03*
D7LA-D7LP	1.15±0.75	1.81±0.67	1.93±0.84	0.04*

Table 2. Number and proportion of individuals according to group and category of the index of asymmetry and results of chi-square test for the association between asymmetry and group

INDEX	GROUP 1		GROUP2		GROUP3	
	N	%	N	%	n	%
IMA 1 X^2 = 3.99 ;p=0.04*						
Dental Asymmetry	9	30	6	20	1	7.14
Symmetry	9	30	5	16.7	1	7.14
Skeletal asymmetry	12	40	19	63.3	12	85.72
Total	30	100	30	100	14	100
IMA2 X^2= 7.19;p=0.01*						
Dental Asymmetry	10	33.3	3	10	1	7.14
Symmetry	6	20	10	33.3	5	35.72
Skeletal asymmetry	14	46.7	17	56.7	8	57.14
Total	30	100	30	100	14	100
IDA1 X^2= 0.37;p=0.02*						
Upper Dental Asymmetry	5	16.7	4	13.3	2	14.3
Lower dental asymmetry	19	63.3	21	70	9	64.4
Symmetry	6	20	5	16.7	3	21.4
Total	30	100	30	100	14	100
IDA2 X^2= 4.06;p=0.03*						
Upper Dental Asymmetry	7	23.3	8	26.7	7	50
Lower dental asymmetry	8	26.7	10	33.3	3	21.4
Symmetry	15	50	12	40	4	28.6
Total	30	100	30	100	14	100

Table 3. Mean and standard deviation of the index of asymmetry and results of the analysis of variance (ANOVA) to test the hypothesis of equality of the means of the three groups, according to the category of asymmetry

INDEX	GROUP 1		GROUP2		GROUP3		
	Mean	S.D	Mean	S.D	Mean	S.D	p value
IMA 1							
Dental Asymmetry	-0.33	0.3	-0.25	0.51	-0.01	0.014	0.010**
Symmetry	-0.15	0.71	-0.2	1.09	0.5	0.0	0.81
Skeletal asymmetry	1.47	0.46	1.76	0.34	1.61	0.65	0.167
IMA2							
Dental Asymmetry	-0.019	0.03	-0.96	0.83	-0.51	0.54	0.016*
Symmetry	-0.08	0.66	0.0	0.70	-0.8	0.44	0.09
Skeletal asymmetry	1.48	0.49	1.61	0.41	1.93	0.49	0.09
IDA1							
Upper Dental Asymmetry	1.32	0.43	1.0	0.01	1	0.0	0.28
Lower dental asymmetry	-0.16	0.38	-0.51	0.54	-0.51	0.62	0.19
Symmetry	-1.58	0.58	-0.9	0.96	-0.83	0.28	0.22
IDA2							
Upper Dental Asymmetry	1.67	0.41	1.43	0.17	1.21	0.39	0.19
Lower dental asymmetry	-0.96	0.83	-0.16	0.55	-0.70	0.60	0.90
Symmetry	-0.46	0.78	-0.83	0.61	-1	1.22	0.34

Standardized lateral cephalometric radiographs were taken with teeth in maximum habitual intercuspation with relaxed lips and face positioned with Camper's plane parallel to the ground (Sıddık Malkoc, 2005). In the present study the mean value of RA-RP(ramus anterior to ramus posterior)(Table1) was found to be 1.52+0.47 in group 1 ,1.66+0.47 in group 2 and 1.64+0.69 in group 3. This showed that the value is higher in Group 2 because the ramus is thicker in patients with retrognathism and is thinner in patients with prognathism. This is in accordance with the study conducted by Epker et al. Considering that a true statement, there is a greater risk of complications during mandibular setbacks than in advancements when the sagittal osteotomy is chosen (Danilo, 2006). There was no significant relation found between different types of skeletal malocclusions when the intergroup comparison was done (p>.05). In the present study the mean value of D6UA-D6UP (anterior molar width to posterior molar width)(Table1) was found to be 1.05+0.68 in group 1, 0.5+0.71in group 2 and 0.21+0.42 in group 3 and the mean value of D7UA-D7UP (anterior molar width to posterior molar width)(Table1) This showed that the value is higher in Group1 because arch widths measured between maxillary second premolars and maxillary first molars were found narrower in the Class II. This is in accordance with the study conducted by Staley et al in which subjects with normal occlusion had larger maxillary molar widths and intermolar width differences than subjects with malocclusion. While evaluating alveolar widths, they reported that maxillary alveolar widths and mandibular alveolar widths of the males were larger in the Class I (Tancan Uysala, 2005). There was a significant relation ($p<0.05$) between the different types of malocclusion when the intergroup comparison was done.

The mean value of D6LA-D6LP(anterior molar width to posterior width) (Table1) was found to be 0.96±0.75 in group 1 , 1.23±0.78 group 2 and 1.80±0.50 in group 3 and the mean value of D7LA-D7LB(anterior molar width to posterior molar width) (from Table1) was found to be 1.15±0.75 in group 1, 1.81±0.67 in group 2 and 1.93±0.84 in group 3 this showed that the value is higher in case of Group 3 as compared to Group 2 and 1 in both the cases because Class III malocclusion has larger mandibular intercanine and intermolar width than Class I and Class III malocclusion. This is in accordance with the study conducted by Braun et al who concluded that the increase in arch width seen in CIII dental arches may be the adaptability of the tongue to the decrease in available arch depth reflected in an increased lateral tongue dimension It may be due to dental compensation, because mandibular posterior teeth were buccally inclined in CIII patients (Akan, 2017). There was a significant relation ($p<0.05$) between the different types of malocclusion when the intergroup comparison was done. The proportion of subjects with skeletal/dental mandibular symmetry, skeletal mandibular asymmetry and dental mandibular asymmetry in the present study was determined by means of Index of Mandibular Asymmetry (IMA)(difference in between the ramus width and molar width) using first lower molar (IMA1) and (IMA2) second lower molar as reference. A greater incidence of mandibular asymmetry was seen in Group 3 as compared to Group 1 and 2 (Table 2). This is in accordance with the study done by Haraguchi et al in which it showed that the mandible is more asymmetrical than the maxilla because of its greater growth potential. While the mandible is a movable bone, the maxilla is rigidly connected to the adjacent skeletal structures by means of sutures and synchondroses.[11] When the means of the three groups according to their category of asymmetry were comapared using (ANOVA) analysis the significant correlations was found in the Index of Mandibular Asymmetry IMA1[(RA-RP)-(D6LA-D6LP)] dental asymmetry group($p<0.05$) (Table3). When the means of the three groups according to their category of asymmetry were comapared using (ANOVA) analysis the significant correlations was found in the Index of Mandibular Asymmetry IMA2[(RA-RP)-(D6LA-D6LP)] dental asymmetry group($p<0.05$) (Table 3). The upper and lower dental asymmetry was determined in the study by using Index of Dental Asymmetry (difference in between the widths of upper and lower molars) (IDA1 and IDA2). From this index using (IDA1) and (IDA2) we found that dental symmetry was greater in Group 1 as compared to Group 2 and Group3(from Table 2) because the maxillary and mandibular alveolar widths are larger in Class I .This is in accordance with the study conducted by Staley et al in which it is stated that palatal movement of maxillary posterior teeth in Class II patients was needed to compensate for the increased overjet and to have good posterior interdigitation.[6] When intergroup comparison was done between different type of skeletal malocclusion, no statistical significant difference was found between them ($p>0.05$). Thus with the advent of lateral cephalogram it has become a vital tool in orthodontic assessment and treatment planning since the introduction of radiography by Broadbent in 1931. This two dimensional radiographic image can be used to assess the skeletal asymmetry in case where there is no accessibility for a three dimensional radiographic diagnostic tools. Thus lateral cephalometric radiography is an acceptable method to identify existing skeletal and dentoalveolar morphological alterations in malocclusion.

Conclusion

The following conclusion drawn from the study were as follows:

- Statistical significant difference was found between different type of skeletal malocclusion.
- Dental asymmetry was found to be greater in Class III malocclusion and Class II malocclusion as compared to Class I malocclusion.
- Skeletal asymmetry was found to be greater in Class III malocclusion and Class II malocclusion as compared to Class I malocclusion.

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