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Evaluation of vertical mandibular asymmetry in different malocclusions- A panoramic study

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ABSTRACT

Aims: The purpose of this study was to compare mandibular asymmetry in different malocclusions, including Angle's Class I malocclusion, Angle's Class II div 1 malocclusion, Angle's Class II div 2 malocclusion, Angle's Class II subdivision and Unilateral posterior cross bite.

Materials and Methods: A total number of 150 subjects with the age range of 18-24 yrs with no signs and symptoms were selected for the study (n=30). The condylar asymmetry index (CAI), ramal asymmetry Index (RAI) and Condylar and Ranal Asymmetry Index (CRAI) for each patient was measured using panoramic radiograph. The results were analyzes using Kappa test, Dahlberg's formula and Tukey HSD Post Hoc test.

Results: Group IV (Angle's Class II subdivision malocclusion) had the maximum Condylar Asymmetry Index (13.07 ±12.43mm) whereas Group II (Angle's Class II div 1 malocclusion) had the minimum Condylar Asymmetry Index (7.89 ±8.71mm). Group III (Angle's Class II div 2 malocclusion) had the maximum Ramus Asymmetry Index (3.84 ± 2.54%) whereas Group II (Angle's Class II div 1 malocclusion) had the minimum Ramus Asymmetry Index (2.82 ± 1.94%). Condylar and Ramus Asymmetry Index was seen in Group IV (Angle's Class II subdivision malocclusion) (3.61 ± 2.43 mm) whereas minimum condylar and ramus asymmetry index was seen in Group V (Unilateral posterior cross bite) (2.42 ± 2.08 mm). However, no statistically significant differences were found.

Conclusion: No statistically significant difference was found in vertical mandibular asymmetry indices when compared in different malocclusions. No gender related statistically significant difference was found in all groups.

1. Introduction

Being a regular occurrence, face symmetry was likely first noticed by the early Greek sculptors, who captured what they had seen in nature—normal facial symmetry.[1] It is well recognised that facial asymmetry plays a significant role in the aetiology of temporomandibular disorders (TMD).[2] The most prevalent asymmetrical characteristic among orthodontic patients is mandibular asymmetries. Because of the mandible's function in the stomatognathic system, asymmetries in it may result in both aesthetic and functional issues. Condylar cartilages shows the highest growth potential on the mandible. Therefore, injuries that occur in these regions throughout the growth period may interfere with the jaw's ability to grow properly, which could cause the mandible to shift towards the side that was injured. Consequently, condylar asymmetries are considered to be one of the most important causes of mandibulofacial

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asymmetries.

Malocclusions have a striking impact on the morphology of the mandibular condyle, according to numerous studies.[3] The mandible, in particular, and possibly the posture of the entire body may grow harmonically as a result of early interceptive or functional therapy. Early cross bite correction, commencing with condyle/ramus shape adjustment can lead to more symmetrical dental and skeletal growth.[4]

In three articles published between 1987 and 1989, Habet's et al[5] proposed an OPG tracing method that sought to determine whether there was a relationship between condyle/ramus height and form and temporomandibular joint abnormalities. This precise procedure solely compared the vertical heights of the rami and condyles on the right and left of the mandible. According to Habets, mandibular posterior vertical asymmetry was defined as an asymmetry index value more than 3%.

A thorough clinical examination, photographic analysis, routine radiographs like lateral cephalograms and panoramic radiographs, supplemental radiographs like posteroanterior cephalograms and submentovertex views, computed tomography, stereometry with or without implants, technitium-99 scintigraphy, etc. can be used to diagnose mandibular asymmetry. However, extra radiographs come with higher radiation exposure as well as additional costs that can occasionally make them unaffordable for the patients. Because of the relatively straightforward nature of the approach and the modest radiation dose that the patient receives, methods to evaluate condylar asymmetry also rely on standardised panoramic radiography measures.[6–9]

However, research investigating the relation between condylar asymmetry and malocclusion have produced conflicting findings.[10–14] A study was done to more thoroughly assess the degree of vertical mandibular asymmetry in various occlusal types in young adult patients as there are conflicting reports about the impact of occlusal type on mandibular vertical asymmetry.

2. Aims and Objectives

The aims and objectives of the study were:

1. To compare mandibular asymmetry in adult subjects with:
   (a) Angle's Class I malocclusion
   (b) Angle's Class II div 1 malocclusion
   (c) Angle's Class II div 2 malocclusion
   (d) Angle's Class II subdivision
   (e) Unilateral posterior cross bite
2. To evaluate gender differences in evaluating mandibular asymmetry

3. Materials and Methods

3.1. Source of data

This retrospective study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Swami Devi Dyal Hospital and Dental College, Barwala, Panchkula (Haryana). This study examined the panoramic radiographs of 150 patients within the age group of 18-26yrs who presented for routine orthodontic treatment.

3.2. Materials (Figure 1)

1. An Orthopantomogram (6 ×12 inches) Planmeca-Proline XC X- ray machine (80kvp, 12 mA, 2.5mm Al)
2. Acetate matte tracing paper (0.003 inches thick)
3. A aharp 3H drawing pencil
4. Masking tape
5. Viewbox
6. Pencil sharpner and eraser
7. Measuring scale
8. Set Squares

3.3. Grouping of subjects

A total of 150 subjects were divided into 5 study groups on the basis of type of occlusion. Group I**,** Group II, Group III, Group IV and Group V (Figure 2).

3.4. Inclusion criteria

1. Inclusion Criteria for group I to IV (study group):
   (a) Dentally Class I, Class II Div 1, Class II div 2 and Class II subdivision.
   (b) Absence of posterior cross bite.
   (c) No clinically diagnosed temporomandibular joint (TMJ) disorders
   (d) No history of previous orthodontic treatment
2. Inclusion Criteria for group V (study group)
   (a) Unilateral posterior cross bites involving atleast 2 posterior teeth in crossbite.
   (b) Mandibular dental midline deviation of atleast 1mm to the crossbite side.
   (c) No remarkable facial asymmetry.
   (d) Absence of any severely malaligned or blocked out teeth.
   (e) No missing teeth, excluding the third molars.

3.5. Methodology

3.5.1. Step: 1 Obtaining the panoramic radiograph

As panoramic radiographs are routinely used as a diagnostic tool in the Department of Orthodontics, patients selected for the study had OPGs available for evaluation which were

taken in a standard manner with Planmeca- Proline XC X-ray machine (80 kvp, 12mA, 2.5mm Al)

3.5.2. Step II. OPG tracing

O.P.G tracing was done for all the five study groups and O.P.G landmarks were marked according to Habet's technique 1988.18 (Figure 3).

Landmarks marked on OPG (Acc to Habet's Technique): (Figure 3)

1. O1 - The most lateral point of the condyle of the mandible
2. O2 - The most lateral point of the ramus of the mandible
3. Line A - A tangent traced to the points O1 and O2
4. Line B - A perpendicular traced to the line (A) tangential to the highest point of the condyle.

3.5.3. Step III: Panoramic measurements for diagnosis of mandibular asymmetry (Habets technique)

Panoramic measurements

The following measurements were taken for diagnosing mandibular asymmetry:

1. Mandibular asymmetry measurements
   (a) **Condylar Height (CH)** - The vertical distance between the lateral point of the condylar image (O1) and the most superior point of the condylar image (on line B).
   (b) **Ramus Height (RH) -** The vertical distance between the lateral point of the condylar image (O1) and the lateral point of the ramus image (O2).
   (c) **Condylar plus Ramal Height (CH + RH) -** The vertical distance between the most superior point of the condylar image (on line B) and the lateral point of the ramus image (O2).
2. Mandibular asymmetry index
   (a) Condylar Asymmetry index

$$\frac{(CH_{right} - CH_{left})}{(CH_{right} + CH_{left})} \times 100$$

   (b) Ramus asymmetry index:

$$\frac{(RH_{right} - CH_{left})}{(RH_{right} + CH_{left})} \times 100$$

   (c) Condylar plus ramus asymmetry index:

$$\frac{(CH_{right} + CH_{left}) - (CH_{left} + RH_{left})}{(CH_{right} + CH_{left}) + (CH_{left} + RH_{left})} \times 100$$

Condylar or ramus asymmetry is indicated if there is a discrepancy of more than 6% between the left and right condyles as measured on the orthopantomogram. According to Habets et al, probable ramus asymmetry is indicated by an index value larger than 3% between the vertical diameters of the rami.

Ten orthopantomograms were picked at random to study the errors related to radiographic measures. After 4 weeks from the initial measurement, their tracings and observations were repeated. The inter- and intra-examiner error was determined using the Kappa test and Dahlberg's formula. The observed Kappa value was 0.86, showing strong agreement between the observers.

Fig. 1: Materials required for study

4. Results

The results were calculated using IBM SPSS (Statistical Package for Social Sciances) Version 22.0 (SPSS Inc, Chicago, IIlinois, USA).

On comparing the condylar heights on right and left side in all study groups, right side measurements were more when compared to the left side condylar height measurements. Maximum variation between the right and left side was seen in Group IV (Angle's Class II subdivision) (right condylar height was 7 ±1.89 > than on left side 6.43± 1.69; p=0.22) and minimum variation was seen in Group III (Angle's Class II div 2) (condylar heights on right side was 7.43±2.25 > than on left side 7.2± 2.38; p=0.7). No statistically significant difference was found when comparing right and left condylar height in all the five groups. (Graph I)

On comparing the ramus heights on right and left side in all study groups, right side measurements were more when compared to the left side ramus height measurements except in Group IV (Angle's Class II subdivision malocclusion) where it was vice versa. Maximum variation between right and left side was seen in Group I (Angle's Class I malocclusion) (right side ramus height was 43.37 ±

Fig. 2: Group 1 to group 5

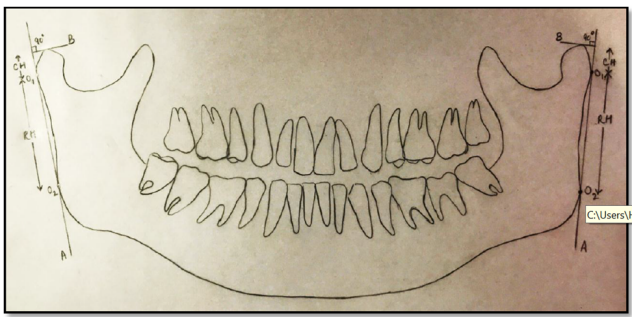

Fig. 3: OPG tracing and landmarks according to Habet's technique

5.12 mm > than on the left side 42 ± 4.88mm, P=0.29.) and minimum variation was seen in Group IV (Angle's Class II subdivision malocclusion) (right ramus height was 42.03± 4.06 < than on left side 42.37± 2.87, P=0.71). No statistically significant difference was found when comparing right and left ramus height in all the five groups. (Table 2)

On comparing the condylar plus ramus heights on right and left side in all study groups, right side measurements were more when compared to the left side condylar plus ramus height measurements. Maximum variation was seen in Class I malocclusion (Angle's Class I malocclusion) (right side condylar plus ramus height was 50.8 ± 5.27 mm > than on the left side 49 ± 4.76 m, p=0.21) and minimum variation was seen in Group IV (Angle's Class II subdivision malocclusion) (right condylar plus ramus height was 49.03 ± 4.8 > than on left side 48.8 ± 4.71, p = 0.85.). No statistically significant difference was found when comparing right and left condylar plus ramus height in all the five groups. (Table 3)

When comparing condylar asymmetry measurements for different groups; Group IV had the maximum Condylar Asymmetry Index (13.07 ±12.43mm) whereas Group II had the minimum Condylar Asymmetry Index (7.89 ±8.71mm) ANOVA test was found to be 1.48 whereas p value was 0.21 which was statistically not significant. (Table 4)

When comparing ramus asymmetry measurements for different groups; Group III had the maximum Ramus Asymmetry Index (3.84 ± 2.54%) whereas Group II had the minimum Ramus Asymmetry Index (2.82 ± 1.94%). ANOVA test was found to be 0.83 whereas p value was 0.51 which was statistically not significant. (Table 5)

When comparing Condylar and Ramus Asymmetry Index for different groups; Maximum Condylar and Ramus Asymmetry Index was seen in Group IV (Angle's Class II subdivision malocclusion) (3.61 ± 2.43 mm). Whereas minimum condylar and ramus asymmetry index was seen in Group V (Unilateral posterior cross bite) (2.42 ± 2.08 mm). ANOVA test was found to be 1.17 and p value was found to be 0.33 which was not statistically significant. (Table 6)

On comparing the Condylar asymmetry index amongst different groups, Female dominance was present in all the groups. Maximum variation was seen in Group I and minimum variation was seen in Group III. On comparison of R.A.I female dominance was present in all the groups except Group I where males had higher R.A.I as compared to females. Maximum variation was seen in Group V and minimum variation was seen in Group II. On comparison of C.R. A. I, in Group II, Group IV and Group V, females had a higher C.R.A.I. as compared to males in the same groups. This was contrary to Group I and Group III where males showed a higher C.R. A. I as compared to females of the same group.

Table 1: Comparison of right and left condylar heights in different malocclusions

Variables	Group	N	Right Mean ±S.D	Left Mean ±S.D	Student	P value
C.H (mm)	Group I	30	7.37 ± 1.77	7.03 ±1.61	0.78	0.44
	Group II	30	7.2 ± 1.09	6.93 ± 1.79	0.71	0.48
	Group III	30	7.43 ± 2.25	7.2 ± 2.38	0.39	0.7
	Group IV	30	7 ± 1.89	6.43 ± 1.69	1.33	0.22
	Group V	30	7.57 ± 1.92	7.2 ± 1.79	0.77	0.44

Table 2: Comparison of right and left ramus height in different groups

Variables	Group	N	Right Mean ± S.D	Left Mean ± S.D	Student	P value
R.H (mm)	Group I	30	43.37±5.12	42 ±4.88	1.06	0.29
	Group II	30	41.8± 4.22	41.4 ±3.91	0.38	0.71
	Group III	30	42.83± 3.60	42.07 ±4.26	0.75	0.46
	Group IV	30	42.03± 4.06	42.37 ±2.87	0.38	0.71
	Group V	30	42.53± 6.33	42.13± 5.6	0.26	0.79

Table 3: Comparison of condylar plus ramus height measurements on right and left side

Variables	Group	N	Right Mean ± S.D	Left Mean ± S.D	Student T test	P value
C.H.R.H. (mm)	Group I	30	50.8 ±5.27	49± 4.76	1.26	0.21
	Group II	30	49.1± 4.33	48.3 ±4.27	0.72	0.47
	Group III	30	50.27± 4.48	49.23 ±4.36	0.91	0.36
	Group IV	30	49.03± 4.8	48.8± 4.71	0.19	0.85
	Group V	30	50.01 ±6.39	49.33 ±5.87	0.49	0.63

Table 4: Condylar asymmetry index

Variables	Group	N	Mean (%)	SD(%)	Anova	p Value
C.A.I. (%)	Group I	30	10.87	9.23		
	Group II	30	7.89	8.71		
	Group III	30	9.31	5.65		
	Group IV	30	13.07	12.43	1.48	0.21
	Group V	30	9.36	6.71		

Table 5: Ramus asymmetry index

Variables	Group	N	Mean (%)	SD(%)	Anova	P Value
R.A.I (%)	Group I	30	3.29	3.35		
	Group II	30	2.89	1.94		
	Group III	30	3.84	2.54	0.83	0.51
	Group IV	30	3.72	2.35		
	Group V	30	3.15	2.19		

Table 6: Condylar and ramus asymmetry index

Variables	Group	N	Mean (%)	SD(%)	Anova	P value
C.R.A.I (%)	Group I	30	2.9	2.73		
	Group II	30	2.51	2.26		
	Group III	30	2.9	2.35	1.17	0.33
	Group IV	30	3.61	2..43		
	Group V	30	2.42	2.08		

5. Discussion

In this study, a panoramic radiograph was employed to support the best possible use of normally accessible radiographs as well as to provide bilateral information. The right and left sides of the condyle and the ramus were linearly measured, and a Habets-based index was calculated between them.[5] Angle's Class II subdivision malocclusion group exhibited the highest Condylar Asymmetry Index in our investigation. Angle's Class II subdivision malocclusion group had the highest condylar and Ramus Asymmetry Indexes, as well as the highest Ramus Asymmetry Index. However, when comparing their results to those of other malocclusion groups, there was no statistically significant difference. Furthermore, no statistically significant gender-related differences were discovered.

Similar findings were made by Kiki A. et al.[14] in 2007 wherein both the control and crossbite groups showed no statistically significant variations in condylar, ramal, or condylar plus ramal heights between the left and right sides. The researchers came to the conclusion that people who had bilateral posterior crossbite may have asymmetric condyles and may be at risk of subsequent skeletal mandibular asymmetries. No statistically significant changes were discovered between the unilateral and bilateral posterior crossbite groups and the normal occlusion sample, according to Uysal T. et al.[15] In 2008, Kurt G. et al.[16] discovered that there was no statistically significant difference between the condylar asymmetry index values in the Class II subdivision group and the normal occlusion group. Vertical condylar, ramus, and condylar plus ramus asymmetry measurements were shown to be unaffected by sex and ANB angle, according to a 2014 study by Sodawala J. et al.[17] Despite a small variation of about 0.5 mm for condylar height (CH) in the low-angle group, Celik et al[18] in 2016 found no statistically significant difference in height measures between right and left sides in each group. According to the level of condylar asymmetry, Kasimoglu et al.'s[13] 2014 research indicated no statistically significant difference between the occlusal kinds.

However, other research published findings that did not agree with our findings. Condylar height was shown to be considerably affected by malocclusions when compared to ramal height, according to Sezgin et al.[19] in 2007. The Class II/1 malocclusion group had significantly higher condylar asymmetry values than the Cl II/2, Cl III, and normal occlusion control groups. Condylar plus ramus ratio measurements were reportedly impacted by the alteration of ANB angle, according to Saglam A.M. et al.[20] in 2003. Taki et al[21] in 2015 came to the conclusion that Class II division I malocclusion had a CAI score that was much greater than Class I malocclusion. Condylar height and corpus length asymmetry index values were higher in the Class II subdivision group than in the Class I subdivision group, according to a 2015 paper by Akin M. et al.[22]

6. Conclusion

1. When comparing condylar asymmetry measurements for different groups (C.A.I.) Group IV (Angle's Class II subdivision malocclusion) had the maximum Condylar Asymmetry Index (13.07 ±12.43mm) whereas Group II (Angle's Class II div 1 malocclusion) had the minimum Condylar Asymmetry Index (7.89 ±8.71mm). However, no statistically significant differences were found.
2. When comparing ramus asymmetry measurements for different groups (R.A.I) Group III (Angle's Class II div 2 malocclusion) had the maximum Ramus Asymmetry Index (3.84 ± 2.54%) whereas Group II (Angle's Class II div 1 malocclusion) had the minimum Ramus Asymmetry Index (2.82 ± 1.94%). However, no statistically significant differences were found.
3. When comparing Condylar and Ramus Asymmetry Index (C.R.A.I.) for different groups, maximum. Condylar and Ramus Asymmetry Index was seen in Group IV (Angle's Class II subdivision malocclusion) (3.61 ± 2.43 mm) whereas minimum condylar and ramus asymmetry index was seen in Group V (Unilateral posterior cross bite) (2.42 ± 2.08 mm). However, no statistically significant differences were found.
4. No statistically significant differences were found in vertical mandibular asymmetry indices when compared in different malocclusions.
5. No gender related statistically significant differences were found.

7. Limitations of the Study

1. Control group comprising of normal occlusion were not included in our study as most of the retrospective data included pretreatment orthodontic records which required orthodontic treatment.
2. Class III and Bilateral posterior cross bite subjects were not included in our study as the retrospective records having these malocclusions were less compared to other malocclusions included in our study.
3. Ideally CBCT or PA cephalogram should be taken for study for diagnosing mandibular asymmetry. Since O.P.G. is routinely used diagnostic aid, it was readily available and patient was not exposed to any additional radiations.

8. Source of Funding

None.

9. Conflict of Interest

None.

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