Research Article

Mandibular Condyle Asymmetry among Different Skeletal Patterns

Dr. Rajiv Yadav[1], Dr. Anil Kumar Yadav[2], Dr. Narayan Pokhrel[3], Dr. Neelam Yadav[4]

[1]Associate Professor and Head, Department of Orthodontics and Dentofacial Orthopedics, Tribhuvan University Dental Teaching Hospital, Institute of Medicine, Maharajgunj Medical Campus, Kathmandu, Nepal

[2]Consultant Orthodontist, Provincial Hospital, Madesh Pradesh, Janakpurdham, Nepal

[3]Consultant Orthodontist, Lumbini Provincial Hospital, Butwal, Lumbini, Nepal

[4]Consultant Prosthodontist, Multi Specialist Dental Hospital Pvt Ltd, Kathmandu, Nepal

Corresponding author: Dr. Rajiv Yadav; Email: drrajivresearch@gmail.com

ABSTRACT

Background: A pleasing face requires symmetry in all three planes. Abnormality in the symmetric growth of condyles is one of the most common causes of facial asymmetry.

Aims and Objective: The objective of this study was to determine the vertical mandibular condyle asymmetry in different skeletal patterns and among genders.

Materials and Method: Pre-treatment lateral cephalograms of 102 subjects (equally divided into three groups: skeletal Class I, Class II and Class III) seeking orthodontic treatment were used to determine the condylar asymmetry. Condylar asymmetry was determined by comparing the heights of the mandibular condyle head and height of ramus on OPG x-rays. Intraclass correlation coefficient (ICC) was used to determine intrapersonal reliability. Mann Whitney test, Kruskal Wallis test was used to find condylar asymmetry index, ramus asymmetry index and condyle plus ramus asymmetry index across the skeletal classes.

Result: Condylar asymmetry index in Class I, Class II, and Class III patients were found to be 5.54%, 6.66%, and 3.68% respectively. Similarly, ramus asymmetry index was 2.03% for Class I, 2.40% for Class II and 1.53% for Class III. The condyle plus ramus asymmetry index was 1.67, 2.01 and 1.34 for Class I, Class II and Class III respectively. All these differences were not statistically significant.

Conclusion: The difference in asymmetry index was insignificant among the Class I, Class II and Class III malocclusions.

KEYWORDS: Condylar Asymmetry, Malocclusion, Skeletal Patterns

INTRODUCTION

A pleasing face requires symmetry in all three planes. An asymmetry in any one of the planes can lead to a compromise in esthetics which can result in abnormal psychological behavior as well. Asymmetry can be in shape, size and location of various orofacial landmarks in opposing sides of sagittal plane.[1] Condylar cartilage is one of the most important growth sites. Abnormality in symmetric growth of condyles is one of the most important causes of asymmetry in face.[2-4] Condylar asymmetry may also be due to an adaptive response of the mandible to deviations during function, which may cause modelling of the condyle and glenoid fossa and mandibular bone.[5]

Although Cone Beam Computed Tomography is a gold standard technique, Kjellberg et al.[6] and Habets et al.[7] suggested that small changes in head position do affect horizontal dimensions, while big changes do not occur in vertical dimensions, allowing vertical asymmetry measurements to be performed on panoramic radiographs. Habets et al[7] evaluated the panoramic radiographs as an aid in the diagnosis of TMDs and concluded that a difference between the right and left condyle of more than 6% measured on orthopantomogram (OPG) indicates condylar asymmetry. Linearly a dimensional difference of more than 2-3 mm between the sides of the mandible has also been considered as asymmetry, which may have clinical relevance.[8,9] Also submento-vertical and poster anterior radiographs[10], photography[11] have been proposed to determine mandibular asymmetries.

Accurate diagnosis of asymmetry is important in orthodontics. Yanez et al.[12] found a moderate-to-severe mandibular asymmetry in more than a half of the sample when both sides of the mandible were measured. Mandibular asymmetries are usually been associated with crossbites[13], Class II subdivision patients[14,15] and the right side predominating over the left when the dimensions of both hemi-mandibles are contrasted8 and Liu et al stated that asymmetry greater than 3% can only be discerned clinically., Using the 6% cutoff, Kambylafkas P[16] reported that the sensitivity of the panoramic x-rays to diagnose asymmetry for the total height was determined to be 0.62 and the specificity 1.0. Saglam AM[17] found condylar and ramus index measurement was affected by change in ANB angle however Sodawala J et al.[18] found condylar and ramus index measurement was not affected by change in ANB angle. Sezgin OS[19] concluded that condylar head height was significantly affected by the occlusion types, whereas ramus height was not affected by occlusion types. Kasimoglu Y et al.[20] also found no statistically significant difference between the occlusion types. Sanders DA[21] concluded that the etiology of Class II subdivision malocclusions is primarily due to an asymmetric mandible that is shorter and positioned posteriorly on the Class II side. Akshita et al in 2017 also concluded that Asymmetric index of condyle shows significant difference between Class II and Class III.[22] Kula et al.[8] stated that a controversy exists as to whether dimensional mandibular asymmetries are considered normal at certain ages. Bajracharya et al.[23] found significant difference in values for condylar asymmetric index in females where as Kasimoglu et al.[20] found no significant difference in values for condylar asymmetric index in males and females. In a recent study by Cardinal et al.[24] no difference in the condyle was found, only the coronoid process was asymmetric in individuals with unilateral posterior crossbite.

Significant condylar asymmetry is noted in different skeletal classes and there is also controversy regarding symmetry of condyles in different age groups, sex, dental and skeletal relations.[17-23] Also using OPG to diagnose condylar symmetry can also help in early diagnosis and prevent the patient from extra X-ray exposures as well. Patients with condylar asymmetry may develop signs and symptoms of TMD earlier than those without such changes. There is possible role of condylar asymmetry on the pathogenesis of craniomandibular disorders and suggested that the use of a screening protocol and a panoramic radiograph could be of preventive importance in daily practice. Significant condylar asymmetry is noted in different skeletal classes and there is also controversy regarding symmetry of condyles in different age groups, sex, dental and skeletal relations. Even though condylar asymmetry is of outmost need in orthodontic treatment, very few studies can be cited in Nepal's literature, hence this study was done to determine the condylar asymmetry in different skeletal patterns. It was also done to compare the condylar asymmetry index among males and females patients undergoing orthodontic treatment.

The aims and objectives of this study was to determine the vertical mandibular condyle asymmetry in different skeletal malocclusion and among genders.

MATERIALS AND METHOD

This was an analytical cross-sectional study conducted at Department of Orthodontics, Tribhuvan University Dental Teaching Hospital, Institute of Medicine, Maharajgunj, Kathmandu. A total of 102 subjects visiting department of orthodontics satisfying the eligibility criteria were selected and enrolled in the study. The inclusion criteria included patients with no signs or symptoms of TMD, no signs of functional shifts and crossbites, no history of any kind of previous orthodontic treatment, no missing teeth, except third molars, good quality lateral cephalogram and panoramic radiographs.

Participants were categorized into Group I: skeletal class I (ANB angle of 1 to 4 degrees) Group II: skeletal class II (ANB angle > 4 degrees) Group III: skeletal class III (ANB angle of < 1 degree). Head holder was fixed to OPG, and the head were centered in the head holder of the OPG as advocated by Habets et al.[7] Age of all samples were >18 years to ensure that mandibular growth had reached adult levels. OPG were traced on the 0.003" size acetate paper. The length of condyle and ramus were measured on both sides with scale with 0.01 accuracy. After basic tracing of the landmarks, the condylar head asymmetry index, ramus asymmetry index and condylar plus ramus asymmetry index was determined in the panoramic radiographs by a method developed by Habets et al.[7] The condylar asymmetry index was determined by using the formula:

Condylar head asymmentry index =

$$\frac{\text{condylar head height right-condylar head height left}}{\text{condylar head height right+condylar head height left}} \times 100$$

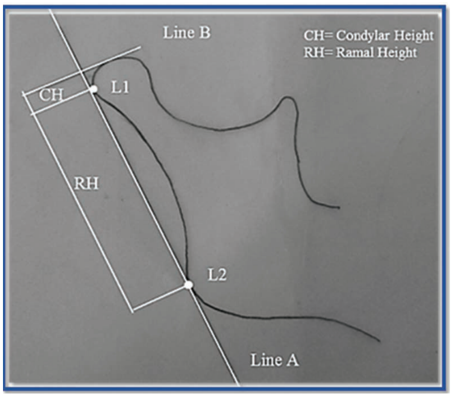

Figure 1. L1 and L2 are the most lateral points of image; Line A is Ramus tangent; and Line B is drawn from most superior point of condyle and perpendicular to Line A. The distance between Line B and point L1 is Condylar Height. The distance between point L1 and point L2 is Ramal Height

All the collected data were entered into Microsoft Excel sheet, data cleaning was done and imported to SPSS version 20.0 for statistical analysis. The condylar asymmetry index was compared between genders and the skeletal class.

All the measurements were performed by one investigator. Twenty radiographs were retraced after two weeks apart for calculating intraclass correlation coefficient (ICC) to check the data reliability. ICC was found to be 0.92 indicating excellent reliability of the measurements.

RESULT

Out of 102 patients in our study, each group contained 34 samples. Out of them, 48 were females and 54 were males (Table 1). The mean condylar length was 8.34 mm and 8.47 mm for right and left side, respectively. Similarly, the mean ramus length was 46.60 mm and 46.36 mm for right and left side, respectively (Table 2).

Table 1. Gender distribution in different skeletal class

Skeletal class	Female	Male	Grand Total
Class I	20	14	34
Class II	16	18	34
Class III	12	22	34
Grand Total	48	54	102

Table 2. Descriptive statistics of different variables

Variable	Minimum (mm)	Maximum (mm)	Mean (mm)	Std. Dev (mm)
Condyle Right	5	14	8.34	1.98
Condyle left	5	15	8.47	1.76
Ramus Right	38	62	46.60	4.97
Ramus Left	37	60	46.36	5.07
Right (ramus plus condyle)	44	72	54.98	6.05
Left (ramus plus condyle)	43	70	54.76	6.08

The tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk) revealed non-normal distribution of the condyle asymmetry index, ramus asymmetry index and condyle plus ramus asymmetry index ($p < 0.001$) and hence non-parametric tests were used to compare the differences among different skeletal class and gender.

The condylar asymmetry index, ramus asymmetry index and condyle plus ramus asymmetry index was not significantly different between two genders when compared with Mann Whitney test (Table 3). Similarly, Kruskal Wallis test did not show any significant difference in the condylar asymmetry index, ramus asymmetry index and condyle plus ramus asymmetry index across the skeletal classes (Table 4).

Table 3. Condylar asymmetry index across gender

Variables	Gender	N	Mean	Std. Dev.	p-value*
Condyle Asymmetry Index	F	48	4.90	5.23	0.498
Condyle Asymmetry Index	M	54	5.65	5.78	
Ramus Asymmetry Index	F	48	2.05	1.80	0.896
Ramus Asymmetry Index	M	54	1.93	1.28	
Condyle Plus ramus asymmetry index	F	48	1.68	1.42	0.904
Condyle Plus ramus asymmetry index	M	54	1.66	1.35	

*Significance value for Mann Whitney Test ($p < 0.05$)

Table 4. Condylar asymmetry index across different skeletal class

Variables	Skeletal Class	Mean	Std. Deviation	p-value*
Condyle Asymmetry Index	I	5.54	4.87	0.49
Condyle Asymmetry Index	II	6.66	6.20	
Condyle Asymmetry Index	III	3.68	5.13	
Ramus Asymmetry Index	I	2.03	1.57	0.41
Ramus Asymmetry Index	II	2.40	1.70	
Ramus Asymmetry Index	III	1.53	1.23	
Condyle Plus ramus asymmetry index	I	1.67	1.11	0.32
Condyle Plus ramus asymmetry index	II	2.01	1.47	
Condyle Plus ramus asymmetry index	III	1.34	1.48	

DISCUSSION

Dentofacial asymmetries assessment are performed by using submentovertex[19] or postero-anterior cephalometric radiographs[20], computed tomography[17,25] and magnetic resonance imaging.[26] Panoramic radiographs are one of the most frequently used viewing technique because it is possible to image joints, teeth, and other parts of the jaws in one exposure. Apart from mandibular measurements such as tooth length or bone height, panoramic radiographs are used as a diagnostic tool even in more complicated situations, such as the evaluation of vertical mandibular asymmetry, condylar and ramal height, TMDs, and gonial angle measurements.[4-7,17,25-30] The use of panoramic radiographs in evaluating mandibular asymmetries concerns the effect of magnification occurring at the vertical dimensions of the mandible on vertical measurements. Most authors suggest that small changes in head position do affect horizontal dimensions, while big changes do not occur in vertical dimensions, allowing vertical asymmetry measurements to be performed on panoramic radiographs.[7,31,32] The panoramic radiographs are used to compare condylar and ramal heights in different experimental groups, such as denture wearers and patients with TMD or orthodontic anomalies.[33-35] Panoramic radiographs provide reproducible vertical and angular measurements.[28]

Habets et al.[32] evaluated the panoramic radiographs as an aid in the diagnosis of TMDs and concluded that a difference between the right and left condyle of more than 6% measured on the panoramic radiograph indicates condylar asymmetry. Similarly in our study, orthopantomogram (OPG) was used for evaluating mandibular asymmetry. Studies on the vertical condylar and ramal asymmetries among gender found no statistically significant differences so difference in sample size among gender of the groups did not seem to be a problem.[16,25,35,36]

In the present study, no significant differences between the groups in condylar asymmetry index and ramus and condyle-plus-ramus symmetry indexes values were found in different skeletal type of malocclusion. In other words, condylar height and ramus height were not significantly affected by the occlusion type. A muscular compensatory mechanism could be responsible for the more symmetrical ramus height and condylar height found on both sides of the subjects with malocclusions. The Habets-method[7] has been used for evaluating condylar and ramal asymmetries in patients with TMD, having different malocclusions. They found that asymmetry index values > 6% must be taken into consideration as vertical asymmetries. In this study, condylar asymmetry index in Class I, Class II, and Class III patients were found 5.54%, 6.66%, and 3.68% respectively, indicating the absence of asymmetry in Class I and Class III skeletal malocclusion. The condylar asymmetry index was present in Class II skeletal malocclusion.

The results in Table 3 and Table 4 reveal no significant differences between the groups in condylar asymmetry index, ramal asymmetry index and condylar and ramal asymmetry index. This means that different occlusal patterns do not affect the vertical symmetry of the mandible at the condylar and ramal level. Other studies that evaluated condylar asymmetry using this method in different malocclusions and in TMD patients also found asymmetry values greater than 6%.[16,25,35,36] These high percentage values can be attributed to shape, angular and positional differences between right and left condyles or systematic measurement errors because of the small dimension of the condyle.

The results of the comparison of the condylar asymmetry index values between the groups show that condylar asymmetry index were significantly increased for skeletal Class II patients which indicates that skeletal Class II malocclusions can act as a predisposing factor for having asymmetric condyles.

Sezgin et al.[19] found that Class I and Class II malocclusions have a significant effect on the condylar asymmetry index when compared to Class III malocclusion. However, our results found Class I and Class II malocclusions have no significant differences. In their study Sezgin et al.[19], found a higher condylar asymmetry index value for Class II group of 8.51% compared to Class I group with condylar asymmetry index value of 6.99%, but with no significant difference between both groups. In our study, Class II malocclusion group showed greater asymmetry compared to the Class I malocclusion but the difference was statistically insignificant.

Moreover, similar results were obtained with Miller and Bodner[27], who investigated the differences in condylar asymmetry index between Class III malocclusion group, and concluded that there was no statistically significant difference between the groups.

However, Sievers et al.[37] assessed possible differences in skeletal asymmetry between patients with skeletal Class I and II relationships and concluded that the discrepant jaw growth resulting in a Class II skeletal pattern results in no more skeletal asymmetry than Class I skeletal patterns; similar to present study findings.

On the other hand, Saglam[17] investigated the effect of angle on condylar asymmetry and concluded that the condylar and ramal asymmetry index measurements were affected by the change of ANB angle, while the condylar asymmetry index and ramal asymmetry index had no influence on the change of ANB angle. In the present study, there were no statistically significant differences between the groups for the ramal asymmetry index and ramal asymmetry index and condylar and ramal asymmetry index values.

As the panoramic radiograph that provides only two-dimensional view was used in the study as a tool for evaluating the vertical mandibular asymmetry, future analysis of mandibular asymmetry should be obtained with the use of three-dimensional cone-beam computed tomography (CBCT). The results of this study can be compared with the results that will be obtained with the use of CBCT. Another limitation of the study is a lack of justification of the sample size, where the study sample was not determined using a power analysis.

CONCLUSION

Class I and Class III have lower condylar asymmetry index than 6% threshold value of Habets et al. and Class II have slightly greater value. Class II and Class I malocclusions patients had higher condylar asymmetry index values compared to Class III group but statistically insignificant The condylar asymmetry index, ramus asymmetry index and condyle plus ramus asymmetry index was not significantly different between two genders.

OJN

REFERENCES

1. Peck S, Peck L, Kataja M. Skeletal asymmetry in esthetically pleasing faces. Angle Orthod 1991;61(1):43-8.
2. Schellhas KP, Piper MA, Omlie MR. Facial skeleton remodeling due to temporomandibular joint degeneration: an imaging study of 100 patients. Cranio 1992;10(3):248-59.
3. Yamashiro T, Okada T, Takada K. Case report: facial asymmetry and early condylar fracture. Angle Orthod 1998;68(1):85-90.
4. Westesson PL, Tallents RH, Katzberg RW, Guay JA. Radiographic assessment of asymmetry of the mandible. AJNR Am J Neuroradiol 1994;15(5):991-9.
5. Pirttiniemi P, Kantomaa T. Relation of glenoid fossa morphology to mandibulofacial asymmetry, studied in dry human Lapp skulls. Acta Odontol Scand 1992;50(4):235-43.
6. Kjellberg H, Ekestubbe A, Kiliaridis S, Thilander B. Condylar height on panoramic radiographs. A methodologic study with a clinical application. Acta Odontol Scand 1994;52(1):43-50.
7. Habets LL, Bezuur JN, Naeiji M, Hansson TL. The Orthopantomogram, an aid in diagnosis of temporomandibular joint problems. II. The vertical symmetry. J Oral Rehabil 1988;15(5):465-71.
8. Kula K, Esmailnejad A, Hass A. Dental arch asymmetry in children with large overjets. Angle Orthod 1998;68(1):45-52.

9. Lu KH. Harmonic analysis of the human face. Biometrics 1965;21:491-505.
10. Forsberg CT, Burstone CJ, Hanley KJ. Diagnosis and treatment planning of skeletal asymmetry with the submental-vertical radiograph. Am J Orthod 1984;85(3):224-37.
11. Edler R, Wertheim D, Greenhill D. Comparison of radiographic and photographic measurement of mandibular asymmetry. Am J Orthod Dentofacial Orthop 2003;123(2):167-74.
12. Ramirez-Yanez G, Stewart A, Franken E, Campos K. Prevalence of mandibular asymmetries in growing patients. European journal of orthodontics 2011;33:236-42.
13. Hesse KL, Artun J, Joondeph DR, Kennedy DB. Changes in condylar postition and occlusion associated with maxillary expansion for correction of functional unilateral posterior crossbite. Am J Orthod Dentofacial Orthop 1997;111(4):410-8.
14. Kurt G, Uysal T, Sisman Y, Ramoglu SI. Mandibular asymmetry in Class II subdivision malocclusion. Angle Orthod 2008;78(1):32-7.
15. Azevedo ARP, Janson G, Henriques JFC, Freitas MRd. Evaluation of asymmetries between subjects with Class II subdivision and apparent facial asymmetry and those with normal occlusion. Am J Orthod Dentofacial Orthop 2006;129(3):376-83.
16. Kambylafkas P, Murdock E, Gilda E, Tallents RH, Kyrkanides S. Validity of panoramic radiographs for measuring mandibular asymmetry. Angle Orthod 2006;76(3):388-93.
17. Saglam AM. The condylar asymmetry measurements in different skeletal patterns. J Oral Rehabil 2003;30(7):738-42.
18. Javed Sodawala SS, Silju Mathew Evaluation of condylar asymmetry in different skeletal patterns in post-adolescents. Ijocr Jan - Mar 2014;Volume 2 (Issue 1).
19. Sezgin OS, Celenk P, Arici S. Mandibular asymmetry in different occlusion patterns. Angle Orthod 2007;77(5):803-7.
20. Kasimoglu Y, Tuna EB, Rahimi B, Marsan G, Gencay K. Condylar asymmetry in different occlusion types. Cranio 2015;33(1):10-4.
21. Sanders DA, Rigali PH, Neace WP, Uribe F, Nanda R. Skeletal and dental asymmetries in Class II subdivision malocclusions using cone-beam computed tomography. American Journal of Orthodontics and Dentofacial Orthopedics 2010;138(5):542.e1-42.e20.
22. Akshita D, Chauhan AK, Jayprakash P, Khetwal D, Baruah P. Evaluation of condylar asymmetry in different skeletal patterns in post-adolescents. International Journal Of Scientific Research 2017;6(1);10-12.
23. Bajracharya, M., Mishra, P., Bhattarai, P., Parajuli, U., Shrestha, R., & Poudel, K. R. (2012). A Radiographic Evaluation of Mandibular Asymmetry in Class II Division 1 Malocculsion Pattern. Orthodontic Journal of Nepal, 2(1), 16–20.
24. Cardinal L, Martins I, Gribel BF, Dominguez GC. Is there an asymmetry of the condylar and coronoid processes of the mandible in individuals with unilateral crossbite? Angle Orthod 2019;89(3):464-69.
25. Rose JM, Sadowsky C, BeGole EA, Moles R. Mandibular skeletal and dental asymmetry in Class II subdivision malocclusions. Am J Orthod Dentofacial Orthop. 1994;105:489–95.
26. Vitral RW, Telles Cde S. Computed tomography evaluation of temporomandibular joint alterations in class II Division 1 subdivision patients: Condylar symmetry. Am J Orthod Dentofacial Orthop. 2002;121:369–75.
27. Miller VJ, Bodner L. Condylar asymmetry measurements in patients with Angle's class III malocclusion. J Oral Rehabil. 1997;24:247–249.
28. Miller VJ. Variation of condylar asymmetry with age in edentulous patients with craniomandibular disorder of myogenous origin. J Prosthet Dent. 1994;71:384–386.
29. Brooks SL, Brand JW, Gibbs SJ, et al. Imaging of the temporomandibular joint: a position paper of the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Endod. 1997;83:609–618.
30. Tu¨rp JC, Vach W, Harbich K, Alt KW, Strub JR. Determining mandibular condyle and ramus height with the help of an orthopantomogram—a valid method? J Oral Rehabil. 1996;23:395–400.
31. Larheim TA, Svanaes DB. Reproducibility of panoramic radiography: mandibular linera dimensions and angles. Am J Orthod Dentofacial Orthop. 1986;90:45–51.
32. Habets LLMH, Bezuur JN, VanOoij CP, Hansson TL. The orthopantomogram, an aid in diagnosis of temporomandibular joint problems. I. The factor of vertical magnification. J Oral Rehabil. 1987;14:475–480
33. Miller VJ, Myers SL, Zeltser CH, Yoeli Z. The relation of age and handedness to condylar asymmetry in a group of edentulous patients with a temporomandibular disorder of arthrogenous origin. J Oral Rehabil. 1995;22:311–313.
34. Raustia AM, Salonen MAM. Gonial angles and ramus height of the mandible in complete denture wearer—a panoramic radiographic study. J Oral Rehabil. 1997;24:512–516.
35. Saglam AM, S¸ anlı G. Condylar asymmetry measurements in temporomandibular disorders. J Contemp Dent Pract. 2005;5:59–65.
36. Yamashiro T, Okada T, Takada K. Case report: facial asymmetryan d early condylar fracture. Angle Orthod. 1998;68: 85–90.
37. Sievers MM, Larson BE, Gaillard PR, Wey A. Asymmetry assessment using cone beam CT. A Class I and Class II patient comparison. Angle Orthod 2012;82:410-7.