ORIGINAL ARTICLE

Orthopantomographic Analysis for Assessment of Mandibular Asymmetry

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ABSTRACT

Objective: The objective of this article is to introduce a simplified analysis for preliminary diagnosis of mandibular asymmetry using digital OPG. The method described in the article involves vertical and angular measurements of mandible. Utilizing digital OPG for preliminary diagnosis of mandibular asymmetry has a favorable cost-benefit relationship and exposes subjects to relatively low doses of radiation.

Keywords: Mandibular asymmetry, Orthopantomographic analysis, Condylar hyperplasia.

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INTRODUCTION

Mandibular asymmetries are the most common asymmetric trait among orthodontic patients.[1] Traditionally, mandibular asymmetry is diagnosed by a combination of tools. These include a thorough clinical examination, photographic analysis, routine radiographs such as lateral cephalogram, panoramic radiograph, additional radiographs like posteroanterior cephalogram, submentovertex view, CT, stereometry with or without implants, Technitium-99 scintigraphy etc.[2-4] However, additional radiographs not only involve increased radiation exposure but also additional expenses, which sometimes become unfeasible to the patients. Panoramic radiograph is commonly used in daily clinical routine and offers an acceptable cost-benefit ratio due to the minimum radiation exposure.[5] This radiograph allows a bilateral view and adequate information on vertical measurements.[5] Studies on panoramic radiography have shown that horizontal measurements tend to be particularly unreliable because of nonlinear variation in magnification at different object depths,[5] whereas vertical and angular measurements are acceptable provided the patient's head is positioned properly in the equipment.[6] The purpose of this article is to provide an analysis involving vertical and angular measurements of mandible done on a digital panoramic radiograph for diagnosing mandibular asymmetries with particular emphasis on differential

diagnosis of condylar hyperplasia (CH), hemimandibular hypertrophy (HH), hemimandibular elongation (HE), coronoid hyperplasia. Dental compensations like altered axial inclination of teeth can also be evaluated to some extent.

Condylar hyperplasia or condylar hyperactivity named by Obwegeser[7] is a pathological overgrowth condition at the condylar process, which leads to variable abnormal mandibular/facial asymmetry. Two different forms of condylar hyperplasia have been differentiated based on the clinical and radiological findings: HH and HE.[8] HH is characterized by a three-dimensional enlargement of one side of the mandible, i.e. the enlargement of the condyle, the condylar neck and the mandibular ramus and corpus.[9] Mandibular midline is in general not shifted.[8,10] A double contour is noticeable on a lateral cephalograms. Orthopantomogram (OPG) reveals increased size of the affected mandibular corpus and ramus and increased distance between the tooth root apices and the inferior mandibular border.[9] The more common condylar hyperplasia type HE, differs in its clinical and radiological view from HH. HE is characterized by a horizontal elongation of the affected hemimandible and may affect the condylar neck, the mandibular ramus and corpus.[8] Condylar head does not seem to be enlarged in HE. A flattening of the gonial angle on the affected side is observed but the mandibular corpus remains on the same level on both sides, which means that no double contour on lateral cephalogram can be seen.[11] Unlike in HH, HE patients do not have an increased height between the tooth root apices and the inferior mandibular border in an OPG examination. Lower dental midline is displaced to the healthy side and the facial asymmetry is very noticeable. A crossbite is noticed commonly on the unaffected side. Coronoid hyperplasia is a rare condition which is macroscopically characterized by an increase in the dimensions of the coronoid process resulting from an abnormal bony elongation of histologically normal bone.[12] According to Akan H and Mehreliyeva N,[13] the average length of coronoid process is 1.92 ± 0.38 cm and the coronoid normally does not

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exceed above zygomatic arch. Measuring the coronoid length may be helpful in diagnosing Jacob's disease in which there is bilateral enlargement of coronoid process which if not assessed may be misdiagnosed as TMJ disorder.

We hypothesize that the method of analysis described in this article can provide a basic tool to study mandibular asymmetries. For precision measurements, 3D computed tomography is undoubtedly the best option.

METHOD

A digital panoramic radiograph made by a standardized technique[14] should be used for the analysis. Radiographs are manually traced on a 75 micron lacquered polyester acetate tracing paper using a 0.35 mm lead pencil.

Following landmarks, horizontal and vertical planes are marked:

Landmarks (Fig. 1)

1. Orbitale (Or): Lowest point on bony orbit
2. Anterior nasal spine (ANS): Tip of bony anterior nasal spine
3. Condylion (Co): Most superior point on head of mandibular condyle
4. Coronoid point (Cor): Most superior point on coronoid process
5. Sigmoid notch point (Snp): Deepest point on sigmoid/mandibular notch
6. Gonion (Go): Most posteroinferior point at the angle of mandible
7. Antegonion (Ag): Highest point of the notch or concavity of the lower border of the ramus where it joins the body of the mandible
8. Mandibular midpoint (M): Located by projecting the mental spine on the lower mandibular border parallel to ANS vertical plane.

Horizontal Plane (Fig. 2)

1. Orbitale plane: Line connecting point orbitale bilaterally
2. ANS horizontal plane: Tangent drawn from ANS parallel to orbitale plane
3. Sigmoid notch planes: Tangent drawn from the deepest point on sigmoid notch parallel to orbitale plane (drawn on the right and left sides separately)
4. Upper occlusal plane: Line connecting mesiobucccal cups of right and left maxillary permanent first molar
5. Lower occlusal plane: Line connecting mesiobucccal cups of right and left mandibular permanent first molar
6. Mandibular plane: Line drawn from the lowermost point on mandible parallel to orbitale plane.

Vertical Plane (Fig. 2)

1. ANS vertical plane: Vertical line drawn from the ANS perpendicular to the orbitale plane.

Following measurements are made:

1. Length of condyle: Measured from the Co to sigmoid notch plane along the long axis of condylar process (Figs 3 and 4)
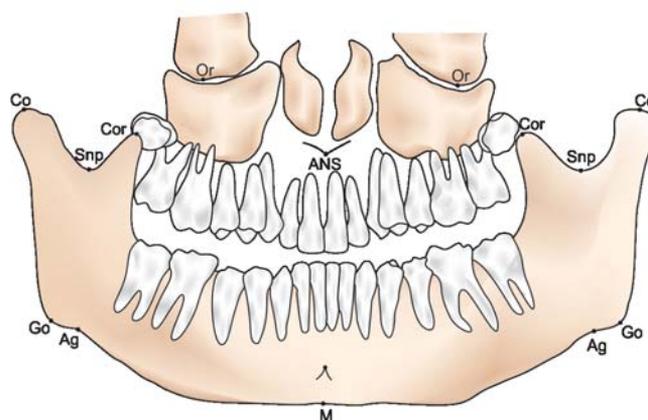

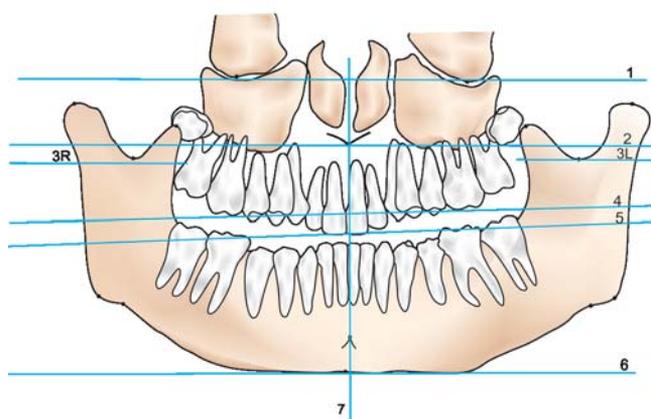**Fig. 1:** Showing OPG tracing and landmarks to be marked

Fig. 2: OPG tracing showing horizontal and vertical planes: (1) Orbitale plane, (2) ANS horizontal plane, (3L) left sigmoid notch plane, (3R) right sigmoid notch plane, (4) upper occlusal plane, (5) lower occlusal plane, (6) mandibular plane, (7) ANS vertical plane
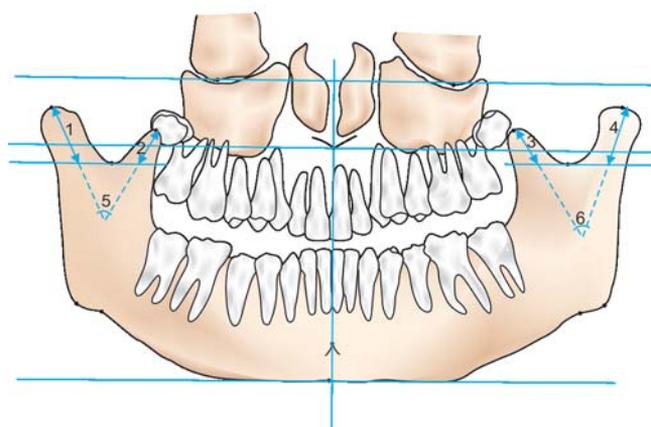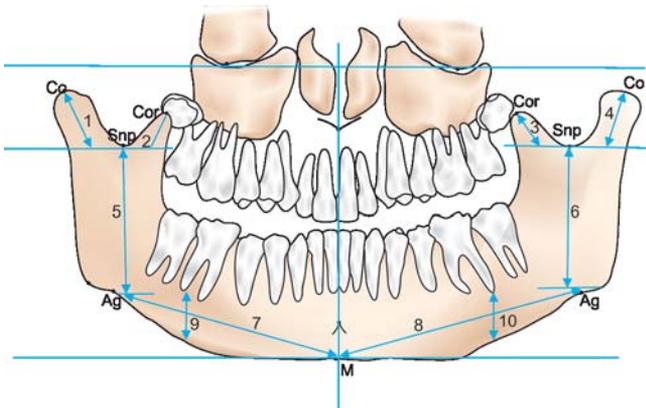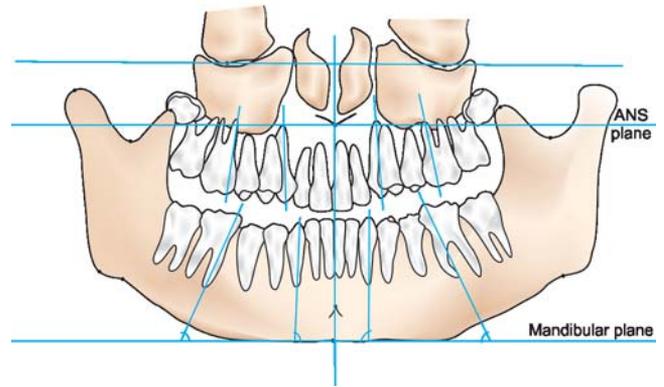

Fig. 3: OPG tracing showing linear and angular measurements of condyle and coronoid process: (1) length of right mandibular condyle, (2) length of right coronoid process, (3) length of left coronoid process, (4) length of left mandibular condyle, (5) angle between right condyle and coronoid process, (6) angle between left condyle and coronoid process
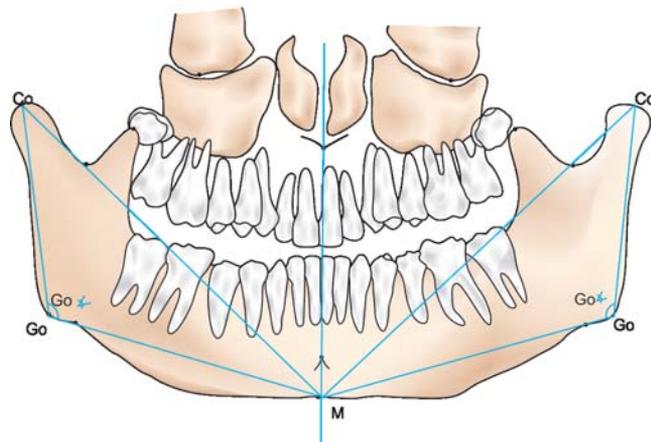
2. Length of coronoid: Measured from the Cor to sigmoid notch plane along the long axis of condylar process (Figs 3 and 4)

Fig. 4: OPG tracing showing linear measurements of mandible: (1) Length of right mandibular condyle, (2) length of right coronoid process, (3) length of left coronoid process, (4) length of left mandibular condyle, (5) length of right ramus (minus condyle and coronoid process), (6) length of left ramus (minus condyle and coronoid process), (7) length of right mandibular corpus, (8) length of left mandibular corpus, (9) height of right mandibular corpus, (10) height of left mandibular corpus

Fig. 6: Comparing right and left dentoalveolar angulations: Figure illustrates angulation of maxillary right and left canine with ANS horizontal plane, angulation of maxillary right and left first molar with ANS horizontal plane, angulation of mandibular right and left canine with mandibular plane, angulation of mandibular right and left first molar with mandibular plane

horizontal plane (for the maxillary molars long axis line passes from mesiobuccal cusp and mesiobuccal root apex).

  b. Mandibular dentoalveolar angulations: Axial inclination of teeth can be assessed by measuring the angle formed between the long axis of individual teeth and the mandibular plane (for the mandibular molars long axis line passes from mesiobuccal cusp and mesial root apex). Dentoalveolar angulations on right and left side are then compared.

10. Cant of occlusion: Upper and lower occlusal planes are drawn by line connecting the mesiobuccal cusps of right and left upper and lower first permanent molars respectively. To assess the cant of occlusion, the parallelism of occlusal plane is compared with the orbitale plane.

The measurements made on the right and left sides are compared and inference is drawn.

SAMPLE CASE

Case Description

A 24-year-old male patient reported complaints of unsatisfactory facial appearance which was progressively becoming worse since 4 years, pain over his right condyle and poor chewing function. Clinical examination showed unilateral elongation of the face, facial asymmetry and increased vertical height of mandible creating a unilateral crossbite from left maxillary central incisor to first molar with dental compensations marked by a supraerupted right maxillary second molar causing its premature contact in CO and CR. Angle's Class III molar and canine relation was seen with mandibular midline deviated to the left by 10 mm (Figs 7 and 8). TMJ examination revealed pain and crepitus in the right TMJ, deviation toward left on mouth opening, restricted right lateral movements, normal mouth opening.

OPG analysis shows (Figs 9 and 10):
* Elongation of right condyle
* Supraerupted upper right second molar, altered inclination of upper and lower incisors indicating dental compensations.

Fig. 5: Assessment of mandibular morphology: Linear measurements Co-Go, Co-M and Go-M are made, also angle Co-Go-M is measured. Linear and angular measurement done on right and left side is then compared

3. Angle between condyle and coronoid process: Formed at the intersection of two longitudinal lines drawn from the Co and Cor along their long axis respectively (Fig. 3)
4. Length of ramus (minus condyle and coronoid process): Measured from point Snp to point Ag (Fig. 4)
5. Length of corpus: Measured from point Ag to point M (Fig. 4)
6. Height of corpus: Distance between the distal root apex of mandibular first molar and inferior mandibular border (Fig. 4)
7. Assessment of mandibular morphology: Left and right triangles are formed by connecting points Co, Go, M. Linear measurements Co-Go, Co-M and Go-M are made, also angle Co-Go-M is measured. Linear and angular measurements done on right and left side are then compared (Fig. 5)
8. Relationship of point Ag to Go-M line should be observed and compared on both sides
9. Dentoalveolar angulations (Fig. 6)
    a. Maxillary dentoalveolar angulations: Axial inclination of teeth can be assessed by measuring the angle formed between the long axis of individual teeth and the ANS

Fig. 7: Sample case: Pretreatment photographs

Fig. 8: Sample case: Pretreatment panoramic radiograph
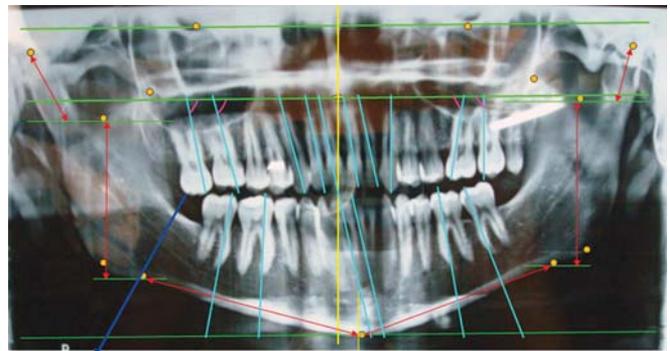
Supra-erupted maxillary right II molar

Fig. 9: Sample case: Relevant tracing done on the panoramic radiograph

Case diagnosis: Elongation of right mandibular condyle with dental compensations marked by a supraerupted upper right second molar causing a functional shift of mandible toward left.

Treatment plan included right condylectomy and orthodontic decompensations. The condylectomized segment was sent for histopathology which confirmed the occurrence of condylar hyperplasia.

DISCUSSION

Diagnosing of mandibular asymmetry is a complex problem. Mandibular asymmetry may be caused by a number of factors like CH, HH, HE, coronoid hyperplasia, TMJ disorders, etc.
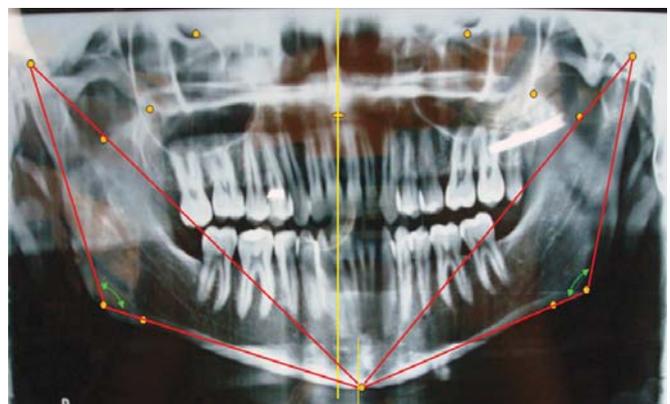

Fig. 10: Sample case: Tracing done on the panoramic radiograph

Though the precise differentiation of these conditions may be confusing, clinical environment requires radiographic impressions at first hand before any other data are available.[15] The panoramic radiograph, considered the current standard of care for dental diagnosis and treatment planning, is used by dentists and orthodontists alike.[16] Panoramic radiograph is relatively accessible and provides a bilateral view of the mandible and vertical measurements can be constructed.[17] A series of reports on the panoramic technique[18-20] suggested that panoramic radiographs yield acceptable results, are noninvasive have a favorable cost-benefit relationship, and expose subjects to relatively low doses of radiation. The shortcomings include distortion and magnification errors especially in horizontal dimension. However, it is important to realize, as suggested by some authors,[6,21] reproducibility of measurements can be acceptable provided patient's head is positioned properly in the equipment. Currently, high quality panoramic machines are being manufactured which have much greater versatility than the conventional panoramic machines.[14] Such machines have a capability for adding on a cephalometric attachment to allow exposure of standardized skull views.

Another important factor for consideration is the need to compare the apparent mesiodistal dimension of the mandibular first molar bilaterally to evaluate any sort of distortion, and if distortion is present, the OPG should be repeated.[14]

Although the vertical and angular measurements on an OPG are reproducible[21] and give us an insight into the possible asymmetry present, it is mandatory to use ratios to compare the right and left side.[22] For example, the ratio of distance Co-M and Ag-M on the right and left sides compared. This would eliminate drawbacks of direct measurements.

The basic aim of this article is to provide the reader with a preliminary screening tool in diagnosing mandibular asymmetries utilizing a digital OPG. With new technologies such as computed tomography (fan beam or cone beam) there is potential to improve diagnostic accuracy and patient treatment.

CONCLUSIONS

- The analysis described gives a gross assessment for diagnosing mandibular asymmetries. Particularly helpful in diagnosing condylar hyperplasia, HH, HE, coronoid hyperplasias, etc.
- Dental compensations like altered axial inclination of teeth can also be evaluated to some extent
- This method can be particularly advantageous as it may reduce the need of additional radiograph in some instances. Thus, minimizing radiation exposure and added cost of additional radiograph to the patient
- Standardized positioning of head during panoramic radiography and use of ratios for comparing right and left sides during OPG analysis can overcome the measurement errors due to magnification and distortion to some extent
- Understanding the limitations of panoramic imaging is required. For precision measurements, 3D computed tomography is undoubtedly the best option.

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