Accuracy of Orthopantogram in Assessment of Tooth Length in Orthodontic Patient

A LITERATURE REVIEW SUBMITTED TO THE COUNCIL OF THE MEDICAL TECHNICAL INISTITUTE IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DIPLOM DEGREE

Prepared By :
Eman Saman
Gazang Raffat
Solin Sulayman
Asma Idres

Supervised by:
Dr. Diyar B. Sabir

2022-2023

Introduction

Rotational panoramic radiography has been important to diagnosis and treatment of dentofacial pathology since its introduction in mainstream dentistry in the 1960's. A major advantage of this type of radiological imaging is patient comfort, ease of use, and low radiation exposure for the patient.[1]

Due to the large area visualized with panoramic radiographs, along with the relatively low radiation dose, panoramic radiographs have been considered as an ideal method of screening for a variety of dentofacial pathologies including cysts, fractures, and dental anomalies.[2]

In orthodontics radiograghy is not only for diagnosis and treatment planning Orthodontic forces have been shown in both experimental and in clinical studies to induce microscopic root resorption.[3]

The major advantages of the orthopantomography (OPG) include less radiation exposure, decreased patient chair time, minimal operator time, better patient co-operation, and added benefit of visualizing of entire lower half of the face . Although panoramic radiography is often used in diagnosis, a full mouth examinationconsisting of 14 or more periapical radiographs is performed occasionally as periapical radiographs are considered to be of higher image quality.[4]

As a single panoramic film can provide same data with less radiation exposure OPG replaced periapical radiographs.

The objective of the present study was to determine reliability and accuracy of tooth length measurements obtained from conventional panoramic radiographs and direct extracted tooth length measurement after extraction in orthodontic patient with digital calipers, considered as the gold standard.[5]

Review of the Litriture

1- Orthopantomography (OPG)

The first attempt to build a dental digital panoramic was of McDavid et al. at University of Texas Health Science Center at SanAntonio (1985-1991), based on a linear pixel array (single pixel column) sensor which was not appropriate for such an application. In 1995, Direct X-ray Imaging System (DXIS), the first dental digital panoramic X-rays system available on the market, created by Catalin Stoichita at Signet (France). DXIS targeted to retrofit all the panoramic models.[6]

The orthopantomogram (OPG) is considered an essential diagnostic aid and should be examined prior to undertaking any orthodontic treatment. It is not available routinely in dental clinics and the patient may require to be referred to special X-ray centers. The biggest advantage of this radiograph is that it provides visualization of a large area of interest to an orthodontist using a single radiograph. With its few drawbacks, these are probably the most frequently preserved records of any orthodontic case in areas where this facility is available.[7]

OPG has an inherent disadvantage that it requires extra space and the equipment, which by itself is expensive, but the radiograph covers the complete dentition and the underlying skeletal structure

1.1 Advantages of an orthopantomogram:

1. Broad information on facial bone and teeth

2. Low patient radiation dose

3. Convenience for the patient (film are located extraorally)

4. Ability to be used in patients who cannot open the mouth or when the opening is restricted

5. Short time required for making the image

6. Patient's ready understand ability of panoramic films, making them a useful visual aid in patient education and case presentation.

7. Easy to store compared to the large set of intra oral x-rays which are typically used.

1.2 Disadvantages of an orthopantomogram

1. Specialized equipment is required.

2. Distortions, magnifications and overlapping of structures area problem.

3. Definition of structures is not as good as in IOPAs.

4. It is not standardized.

5. lOPAs may still be required.[8]

1.3 Uses of Orthopantomogram:

• Evaluation of third molars.

• Evaluation of tooth development.

• To evaluate impacted teeth.

• To evaluate eruption patterns, growth and development.

• To detect diseases, lesions and conditions of the jaw (eg: Carcinoma in relation to the jaws), or Diagnosis of developmental anomalies such as Cherubism, Cleidocranial dysplasia.

• To examine extent of large lesions.

To evaluate tempero-mandibular joint dysfunctions and ankylosis.

• To evaluate trauma, periodontal bone loss and periapical involvement.

• Assessment for the placement of dental implants.

• Orthodontic assessment. pre-and post- operatively.

• Intolerant to intraoral procedures (Use in patients unable to open their mouth).

• In patient education and case presentation.[9]

1.4 Limitations of Orthopantomogram:

1- Image clarity is limited, particularly in the anterior area.

2- Magnification in the vertical plane.

3- Lack of 3-dimensional information.

4- May lead to false negative diagnosis of maxillary sinus septa due to low sensitivity and specificity.

5- Risk of overestimating bone quantity after sinus grafting procedures.

1.5 How to read the orthopantomography

Step 1

Orient the radiograph as when looking at the patient, i.e. with the patient's left side positioned on the clinician's right. The radiograph is then placed on a view box, which is uniformly lit (Fig. I). Prefer to dim the remaining lights in the room.[2]

Fig (1) OPG viewer

Step 2

Start examining from the right condylar head and follow the outline along the neck and the posterior border of the ramus. Continue following the outline of the mandibular body to the symphyseal region anteriorly along the lower border of the mandible to the left condyle. Compare the outline for discontinu ties, radiopacities or radiolucencies and most importantly from an orthodontic perspective for symmetry. Asymmetry may result from faulty positioning of the patient or that of the cassette in its holder.[4]

Note the thickness and density of the mandibular cortex and the other structures including the mandibular canals, mental foramina, and the coronoid process (fig 2).

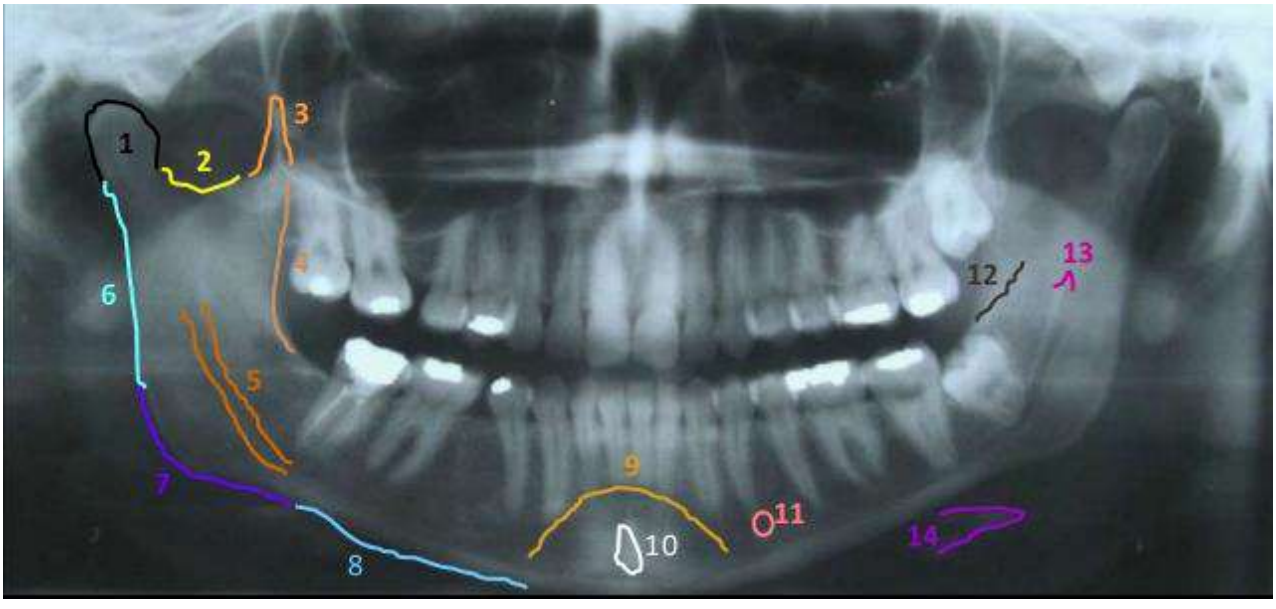


Fig 2. Bony landmarks in mandible 1. Condylar head 2. Sigmoid notch 3. Coronoid process 4. External obligue ridge 5. Mandibular canal 6. Posterior border of ramus 7. Gonial angle 8. Lower border of mandible 9. Mental ridge 10. Genial tubercle 11. Mental foramen 12. Extwrnal oblique ridge 13. Lingula 14. Hyoid bone.

Step 3

Examine the medullary bone of the mandible for the usual anatomic landmarks and note anything suggestive of pathology, especially in the periapical regions of the teeth (Fig 3). The third molar development and position should definitely be noted as it may play an important role in determining the type of retention planned and/or their enucleation if required.

Fig 3. Orthopantomogram shows periapical pathology and third molar angulation.

Step 4

Next, examine the cortical outline of the maxilla starting on the right side. Trace the pterygo-maxillary fissure, hard palate with the anterior nasal spine.

Examine the nasal cavities and the nasal septum followed by the maxillary sinuses. It is advisable to compare the right and left sides especially of the nasal cavities and the maxillary sinuses (Fig 4). Radiopacities in these regions could be suggestive of pathology (Fig. 5) or sometimes the presence of foreign body. These might reflect upon the breathing pattern of the patient.[10]

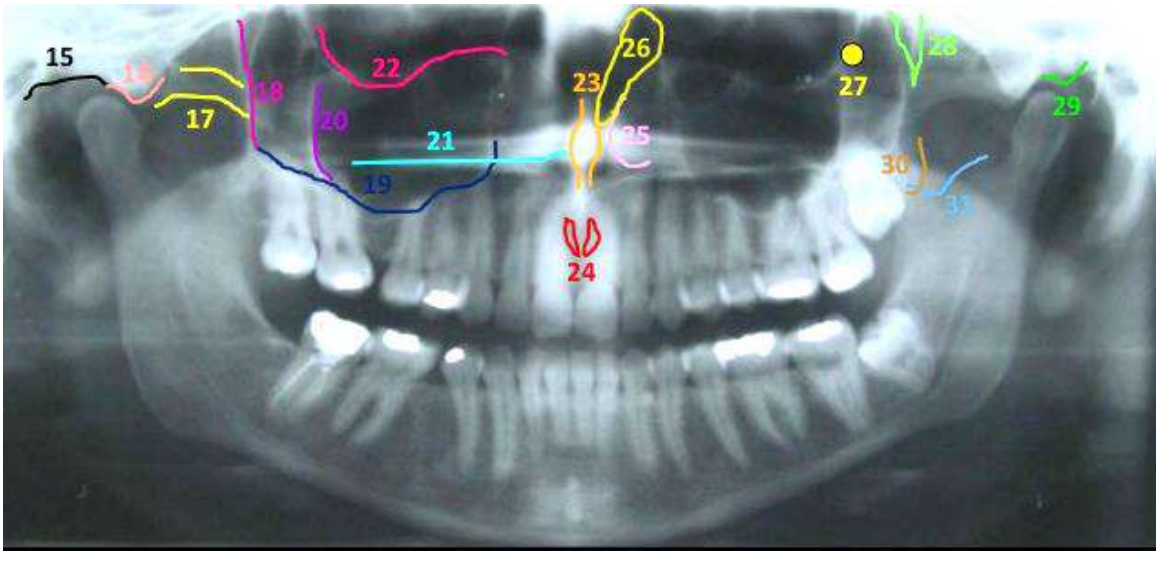


Fig 4. Body landmark in maxilla, 15. Glenoid fossa 19. Floor of Maxillary sinus 17. Zygomatic Arch 16. Articular eminence 18.Posterior wall maxillary sinus 20. Zygomatic process of maxilla forming innominate line 21. Hard palate 22. Floor of the orbit 23. Nasal septum 24. Incisive foramen 25. Inferior choncha 26. Meatus 27. Frontal process of Zygomatic bone 28.Pterygo maxillary fissure 29.Spine of the sphenoid bone 30. Maxillary tuberosity 31. Lateral pterygoid plate.[11]

Step 5

Finally evaluate the teeth for-presence, stage of development, state of eruption unerupted or impacted teeth, placement, root morphology and position, cavities, fractures, contacts, and/or any pathology (Fig 8). These findings have to be clinically correlated and/or with IOPA's or bitewing radiographs.

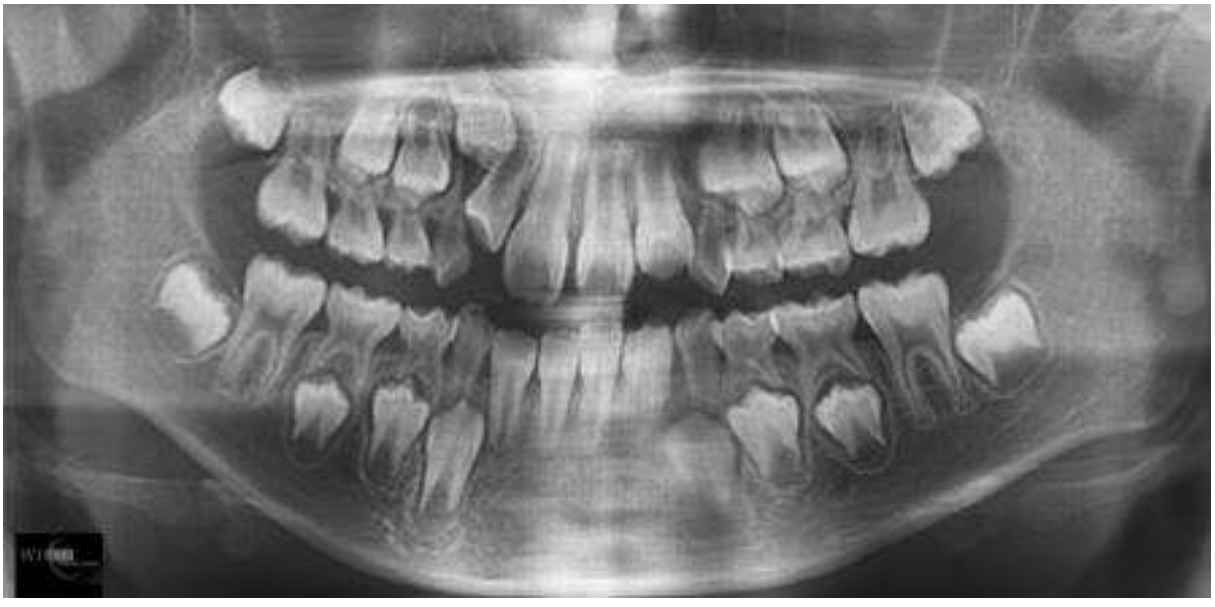


Fig 5. Orthopantomogram showing mixed dentition

Teeth may appear to be magnified or minimized in the horizontal dimension depending on their position. The maxillary and mandibular cusp tips should be generally separate (unless there is a change in the cant of occlusion and there should be gentle curve to the occlusal plane. The orthopantomogram may not be sufficient by itself. If any doubt arises it is recommended that an lOPA of the concerned region be taken[13]. (Fig 6).

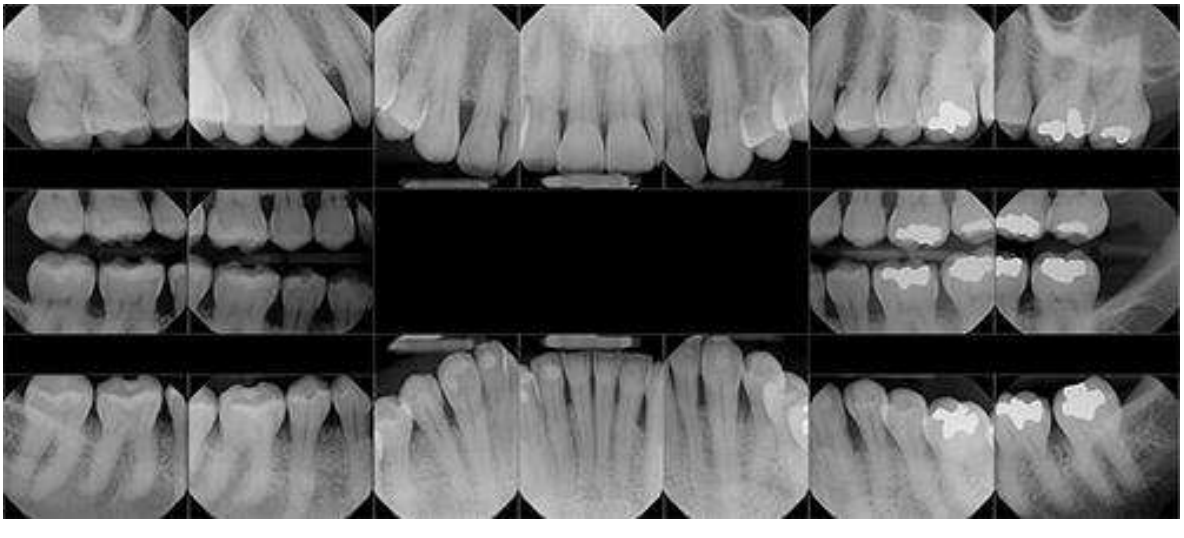


Fig 6. Intraoral periapical radiographs (IOPAs) with bitewing radiographs

2-Diagnostic aids: Other views used orthodontic diagnosis:

2.1 INTRAORAL RADIOGRAPHS

The intraoral radiographs are the easiest to take for most orthodontic patients. They formed the mainstay for all orthodontists till the advent of the orthopantomogram. Still they are the most frequently used as all centers may not possess the orthopantomogram.[14]

They are also recommended for specific regions in all cases where a doubt remains regarding the clarity of the orthopantomogram as seen below. The most frequently used views are intraoral periapical radiographs (IOPA), bitewing radiographs and occlusal radiographs.[13]

2.2 Intraoral Periapical Radiographs

A full set of ten IOPAs was recommended before the advent of the orthopantomogram. They covered all the present teeth and the adjacent teeth. They are still ideal for the detection of anomalies related to changes in the size, shape and content of the tooth structure and / or the lamina dura and/ or the periapical region.

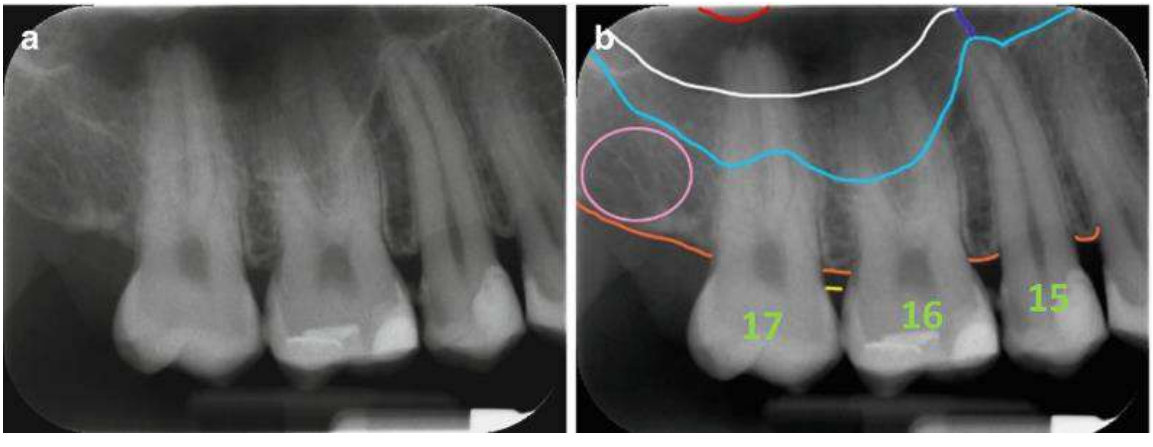


Fig.(7) PA radiograph for right maxillary posterior teeth. Maxillary sinus border, level of alveolar bone, tuberosity

The main disadvantages of the IOPAs includes the increased radiation that a person has to undergo to cover the full complement of his/her teeth. Also at times the patient is not cooperative, and may not allow the repeated placement of films in the desired manner in his/her mouth.[15]

With the increased use of OPGs, the use of IOPAs has reduced considerably. Yet, they are ideal for localized views in relatively small areas of interest because of the excellent clarity that they allow.

To evaluate the position of the canine buccolingually two periapical films are taken of the same area, with the horizontal angulation of the cone changed when the second film is taken. If the object in question moves in the same direction as the cone, it is lingually positioned. If the object moves in the opposite direction, it is situated closer to the source of radiation and is therefore buccally located (Fig 10). This is called Tube-shift technique or Clark's rule or (SLOB) rule.[9]

Fig 8. Tube shift technique. The canine located palatally as the tooth moves with the same direction of the cone.

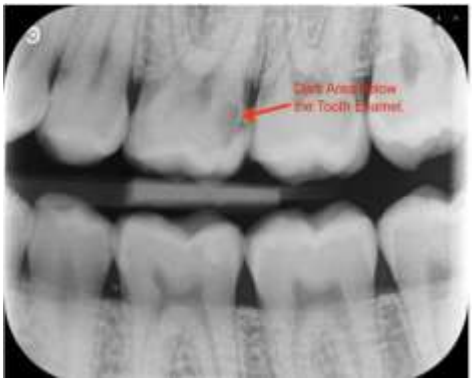
2.3 Bitewing Radiographs

They are seldom used but are ideal for the detection of proximal caries and the study of interdental bone height in these areas.

2.4 Occlusal Radiographs

lntraoral occlusal radiographs are of special interest to an orthodontist when dealing with impacted teeth or for the study of the labio-lingual position of the root apices in the anterior segments of the maxillary and the mandibular dentition.[10]

They are particularly useful in the maxillary arch, for assessing root form of the incisors, the presence of midline supernumerary teeth and canine position, either alone or in combination with additional views using parallax.[15]



Bitewing radiograph Occlusal radiograph

Bitewing radiograph Occlusal radiograph

REFERENCES

1. Tohnak S, Mehnert A, Crozier S, Mahoney M. Synthesizing panoramic radiographs by unwrapping dental CT data. Conf Proc IEEE Eng Med Biol Soc. 2006;1:3329-32.

2. Van Elslande DC, Russett SJ, Major PW, Flores-Mir C. Mandibular asymmetry diagnosis with panoramic imaging. Am J Orthod Dentofacial Orthop. 2008;134(2):183-92.

3. Tronje G, Eliasson S, Julin P, Welander U. Image distortion in rotational panoramic radiography. II. Vertical distances. Acta Radiol Diagn (Stockh). 1981;22(4):449-55.

4. Larheim TA, Svanaes DB. Reproducibility of rotational panoramic radiography: mandibular linear dimensions and angles. Am J Orthod Dentofacial Orthop. 1986;90(1):45-51.

5. 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.

6. Turp 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(6):395-400.

7. Kaley J, Phillips C. Factors related to root resorption in edgewise practice. Angle Orthod. 1991;61(2):125-32.

8. Berco M, Rigali PH Jr, Miner RM, DeLuca S, Anderson NK, Will LA. Accuracy and reliability of linear cephalometric measurements from cone-beam computed tomography scans of a dry human skull. Am J Orthod Dentofacial Orthop. 2009;136(1):17.e11-9.

9. Ballrick JW, Palomo JM, Ruch E, Amberman BD, Hans MG. Image distortion and spatial resolution of a commercially available cone-beam computed tomography machine. Am J Orthod Dentofacial Orthop. 2008;134(4):573-82.

10. Lagravere MO, Carey J, Toogood RW, Major PW. Three-dimensional accuracy of measurements made with software on cone-beam computed tomography images. Am J Orthod Dentofacial Orthop. 2008;134(1):112-6.

11. Ludlow JB, Laster WS, See M, Bailey LTJ, Hershey HG. Accuracy of measurements of mandibular anatomy in cone beam computed tomography images. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(4):534-42.

12. Copeland S, Green LJ. Root resorption in maxillary central incisors following active orthodontic treatment. Am J Orthod. 1986;89(1):51-5.

13. Mohandesan H, Ravanmehr H, Valaei N. A radiographic analysis of external apical root resorption of maxillary incisors during active orthodontic treatment. Eur J Orthod. 2007;29(2):134-9.

14. Yitschaky M, Haviv Y, Aframian DJ, Abed Y, Redlich M. Prediction of premolar tooth lengths based on their panoramic radiographic lengths. Dentomaxillofac Radiol. 2004;33(6):370-2.

15. Garcia-Figueroa MA, Raboud DW, Lam EW, Heo G, Major PW. Effect of buccolingual root angulation on the mesiodistal angulation shown on panoramic radiographs. Am J Orthod Dentofacial Orthop. 2008;134(1):93-9.