A Simplified Overview on Clinical Cephalometrics

PJ Antony, S Karthiga Kannan, Joby Paulose, Manu M Mathew, Charis Chandy Joseph

ABSTRACT

Cephalometrics has always been the mainstay in clinical orthodontics for diagnosis, growth prediction, treatment planning, treatment evaluation and for research purpose. Even though traditional cephalometrics has been used in orthodontics for a very long time; it still has potential drawbacks of high-risk of errors which involve projection/acquisition errors, landmark identification errors and technical measurement errors. Even slight deviations from the prescribed standardized technique which may even be obscure in the initial screening often pose difficulty for the clinician performing the cephalometric analysis. This article aims to discuss the commonly encountered errors in cephalometry and to present a simplified and reproducible method of cephalometric tracing for all clinicians.

Keywords: Cephalometrics, Diagnosis and treatment planning, Lateral cephalogram.


Source of support: Nil
Conflict of interest: None

INTRODUCTION

Broadbent in 1931 introduced cephalometric radiography to overcome the shortcomings of earlier techniques in the field.1 The need for standardization of the classical lateral projection of the skull led to the development of cephalometrics, and it has since then become the mainstay in clinical orthodontics for diagnosis, growth prediction, treatment planning, treatment evaluation and for research purpose. Cephalometric include measurements, description and appraisal of the morphologic configuration and growth changes in the skull by ascertaining the dimensions of lines, angles and planes between anthropometric landmarks established by physical anthropologists and points selected by orthodontists. Cephalometric films could be used to evaluate dentofacial proportions and clarify the anatomic basis for a malocclusion. Frontal and lateral cephalogram forms a comprehensive diagnostic aid which allows us to evaluate the facial skeleton as well as the soft tissue in all the three planes. Cephalometric radiography is extensively used by orthodontists and maxillofacial surgeons as important analytic, descriptive and diagnostic tool. Even slight deviations from the prescribed standardized technique which may even be obscure during the initial screening often pose difficulty for the clinician performing the cephalometric analysis.

Standardization of the lateral cephalogram to obtain an ideal radiograph is a necessity for optimal accuracy in comparing the cephalometric data among different individuals as well as in same subjects. A standardized technique has to be carried out to avoid errors. A precise knowledge on the influence of technique errors on cephalometric measurements has to be clearly understood so as to avoid faulty diagnosis.

ERRORS IN LATERAL CEPHALOGRAM

Even though lateral cephalogram has been in use for decades, there are some errors which are commonly associated with it. They can be classified into three categories:
1. Projection/acquisition errors
2. Landmark identification errors
3. Technical measurement errors.

Projection errors are caused by faulty technique which involves wrong head positioning while acquiring the radiograph. These errors may occur in transverse/horizontal, vertical and anteroposterior plane when the head rotates around any of these axes. Rotation of head in the anteroposterior axis affects the linear measurements recorded in vertical plane.4,5 Similarly, rotations occurring in the vertical axis will affect the linear measurements recorded in the anteroposterior plane. Researchers have reported minimal distortion in the midsagittal structures on a lateral cephalogram due to variation in head orientation compared to bilateral ones.2,3 Three to 10° of head tilt were reported by many researchers despite of proper head positioning.

Landmark identification error may be as a result of faulty patient positioning or due to inexperience of the clinician assessing the radiograph. Head rotations in a vertical and anteroposterior axis result in duplication of bilateral structures whereas the median structures remain unaffected. This in turn will affect the reliability, reproducibility and validity of landmarks like porion, orbitale, pterygomaxillary fissure, condyion, articular and gonion.6 However, a head rotation in the transverse axis does not cause errors in any measurements recorded because it causes only a change in the position of the head on the radiograph, whereas a change in rotation on the other two axes leads to a change in the landmarks.5,7 High interobserver variability in the landmark identification exists due to a bias in the landmark identification by different clinicians. Less often, it may also be a result of poor understanding of the crucial landmarks. There are some landmarks which are highly inconsistent in its location.
Technical errors are errors associated with measuring system. The first computerized measuring devices were electromechanical and usually had built-in sources for parallax and mechanical errors. However, the modern digitizers have eliminated these problems. An accuracy of 0.1 mm is desirable without any distortion over the digitizer. Although the errors in digital cephalometrics are considered to be negligible, studies has been shown that digitizers may suffer from varying degree of scaling and nonlinearity.

GUIDELINES TO ELIMINATE OR MINIMIZE ERRORS IN CEPHALOMETRICS

The main sources of projection errors are due to wrong head position. It can be rectified by meticulously maintaining natural head position while acquiring lateral cephalogram. Placing the infraorbital pointer at the patients infraorbital foramen and then adjusting the head till the ear rods and the pointer are at the same level to achieve the standardized Frankfort plane while the upper part of the face is supported by the forehead clamp positioned at the nasion. If it is necessary for the cephalogram to be produced in the natural head position which represents the true horizontal plane, the patient should be standing up and look directly into the reflection of his/her own eyes in the mirror kept directly in front of him. The ear rods do allow a small adjustment of the head which often may lead to an undesirable lateral tilt or rotation. The projection is taken when the teeth are in centric occlusion and the lips are in repose unless other specifications have been recommended. The focus film distance is usually five feet but different distances have also been reported. Usually, the left side is made to face the cassette. Landmark identification errors can be minimized by keeping the patient’s head in the natural head position while acquiring cephalogram. Thorough knowledge of landmarks is also necessary to eliminate errors while tracing cephalogram. Some of the important landmarks in cephalogram are as follows:

1. **Po (porion):** Highest bony point on the upper margin of external auditory meatus.
2. **Ptm (pterygomaxillary fissure):** It is the intersection of the inferior border of foramen rotundum with the posterior wall of the pterygomaxillary fissure.
3. **Or (orbitale):** Lower most point on the inferior bony margin of orbit.
4. **Ar (articulare):** Point at the intersection of the posterior margin of ascending ramus and inferior border of the basilar part of occipital bone.
5. **Go (gonion):** Constructed point at the intersection of ramal and mandibular plane.
6. **Co (condylion):** The most superior point on the head of mandibular condyle.

The problems associated in locating the above-mentioned landmarks due to head tilt in an anteroposterior and vertical axis is enumerated in Figures 1 and 2.

TRACING TECHNIQUE

**General Consideration**

The lateral cephalogram is placed on view box with patient image facing right side. Three crosses are made on the radiograph, two within the cranium and one over cervical vertebrae for reorientation. Place the acetate overlay tracing sheet over the radiograph with shiny surface toward it and tape it. Then, trace the three crosses. With smooth continuous pressure, start tracing and try not to lift pencil.

Tracing should be divided in four sections: First step involves tracing of soft tissue and external contour of cranium, outlines of atlas and axis vertebrae (Fig. 3). Second step involves tracing of internal border of cranium parallel to external border followed by orbital roof, pituitary fossa with anterior and posterior clenoid fossa, planum sphenoidal anterior to sella, frontal sinus, dorsum sella continues posterior inferiorly and then external auditory meatus which is posteriormost to superior to ear rods (Fig. 4). Third step includes tracing of maxilla, outline of nasal bone, lateral orbital margins and infraorbital ridges then bilaterally present zygomatic process of maxilla-key ridge, pterygomaxillary fissure which has a tear drop shape and it point toward posterior nasal spine, palatine bone with anterior and posterior nasal spine, maxillary 1st molar outline anterior outline of maxilla from anterior nasal spine inferiorly and the most anteriorly positioned incisor (Fig. 5). The final step in tracing involves tracing of the mandible, anterior border of symphysis, narrow space of symphysis and the inferior border of mandible. An average of both right and left outlines is recorded in case two borders are visible. It is followed by posterior aspect of ramus then the mandibular condyle, mandibular notch, coronoid process, anterior aspect of rami, and mandibular canal mandibular 1st molar. One should always confirm the molar relationship in dental cast when in doubt. Finally, most anteriorly placed lower incisor is traced (Fig. 6).
Fig. 1: Demonstrating head rotation in anteroposterior axis: (A) Porion point not clearly visible; (B) TMJ appears superimposed with cranial structures, hence Ar and Co cannot be located; (C) Ptm point not clear; (D) Orbitale could not be located; (E) Right and left angle seen. Gonion cannot be marked correctly.

Fig. 2: Demonstrating head rotation in vertical axis: (A) Porion point not clearly visible; (B) TMJ on both, right and left side visible as separate structures, hence Ar and Co cannot be located; (C) Ptm point not clear; (D) Posterior border of ramus and inferior border of mandible on both right and left are visible. Difficult in locating Go and mandibular plane; (E) Incisal tip as well as root apex of upper and lower incisor not clear.

Fig. 3: First step in tracing
Fig. 4: Second step in tracing
Fig. 5: Third step in tracing
Fig. 6: Fourth step in tracing
ADVANCED CEPHALOMETRICS ANALYSIS

Current clinicians are transitioning to paperless offices and have started obtaining digital records. The recent advances in technology have resulted in the development of filmless radiographs equipments. Currently, 3D cephalometry is being widely used. Though digital radiology has its own merits over film-based systems, there are no differences in identifying cephalometric landmarks on conventional film-based or digital cephalograms. Cephalometric analysis initially done by manual hand tracing on an acetate sheet is presently performed using computer-based tracing software. With the advent of computerized cephalometric softwares like Dolphin imaging, NemoCeph, OrisCeph, CephSmile, FACAD, Audax, etc. analysis can be done with a few clicks. All the analysis is done by the software itself in a matter of seconds. It is very convenient and save considerable amount of time. However even, this method is prone to errors as the anatomical landmarks are marked by the clinician. Any error in landmark identification will naturally affect the outcome of the analysis. So irrespective of the methods used in tracing cephalogram, whether manual or computerized landmark identification holds equal importance.

CONCLUSION

Lateral cephalogram is a great adjunct in the diagnosis and treatment planning. Errors can be minimized if we strictly follow the guidelines while acquiring the radiograph. Thorough understanding of the landmarks and structures while tracing the lateral cephalogram is also of utmost importance to limit the errors to a great extent. This will allow the clinician whether a radiologist or an orthodontist to evaluate the radiograph properly to diagnose and formulate the treatment plan best suited for our patients.

REFERENCES


ABOUT THE AUTHORS

PJ Antony (Corresponding Author)
Professor and Head, Department of Orthodontics, Mar Baselios Dental College, Kothamangalam, Kerala, India
Phone: 04852828745
e-mail: pjantony1989@gmail.com

S Karthiga Kannan
Principal and Professor, Department of Oral Medicine and Radiology Mar Baselios Dental College, Kothamangalam, Kerala, India

Joby Paulose
Reader, Department of Orthodontics, Mar Baselios Dental College Kothamangalam, Kerala, India

Manu M Mathew
Senior Lecturer, Department of Orthodontics, Mar Baselios Dental College, Kothamangalam, Kerala, India

Charis Chandy Joseph
Senior Lecturer, Department of Oral Medicine and Radiology, Mar Baselios Dental College, Kothamangalam, Kerala, India