Cephalometric

Cephalometry is the analysis and interpretation of standardized radiographs of the facial bones. In practice, cephalometrics has come to be associated with a true lateral view.

The Cephalostat:

In order to be able to compare the cephalometric radiographs of one patient taken on different occasions, or those of different individuals, some standardization is necessary. To achieve this aim the cephalostat was developed by B. Holly Broadbent in the period after the First World War. The cephalostat consists of an X-ray machine which is at a fixed distance from a set of ear posts designed to fit into the patient's external auditory meatus. Thus the central beam of the machine is directed towards the ear posts, which also serve to stabilize the patient's head. The position of the head in the vertical axis is standardized by ensuring that the patient's Frankfort plane is horizontal. This can be done be manually positioning the subject with the aid of ear post and nose rod or, alternatively, by placing a mirror some distance away level with the patient's head and asking him or her to look into their own eyes. This is termed the natural head position.

The distances from the tube to the patient (usually between 5-6 feet (1.5-1.8m)) & from the patient to the film (usually 1-foot(around 30cm)) entirely successful to reduce the magnification, which is usually of the order from 7 - 8%, such a magnification is difficult' to overcome.

To give a better definition of the soft tissue outline of the face, either thin layer of barium paste can placed down the central axis of the face or an aluminum wedge positioned so as to attenuate the beam in that area.

Indication for cephalometric evaluation:

✓ ***An aid to diagnosis:*** it is possible to carry out successful orthodontic treatment without taking a cephalometric radiograph, particularly in Class I malocclusions. However, the information that cephalometric analysis yields is helpful in assessing the probable etiology of a malocclusion and in planning

treatment. The benefit to the patient in terms of the additional information gained must be weighed against the X-ray dosage. Therefore a lateral cephalometric radiograph is best limited to patients with a skeletal discrepancy and/or where antero-posterior movement of the incisors is planned. In a small proportion of patients it may be helpful to monitor growth to aid the planning and timing of treatment by taking serial cephalometric radiographs, although again the dosage to the patient must be justifiable.

✓ ***A pre-treatment record:*** a lateral cephalometric radiograph is useful in providing a baseline record prior to the placement of appliances, particularly where movement of the upper and lower incisors is planned.

✓ ***Monitoring the progress of treatment:*** In the management of severe malocclusions, where tooth movement is occurring in all three planes of space (for example treatments involving functional appliances, or upper and lower fixed appliances), it may be helpful to take a lateral cephalometric radiograph during treatment to monitor incisor inclinations and anchorage requirements. A lateral cephalometric radiograph may also be useful in monitoring the movement of unerupted teeth and for assessing upper incisor root resorption if this is felt to be a potential risk during treatment.

✓ ***Research purposes***: a great deal of information has been obtained about growth &development by longitudinal studies which involved taking several cephalometric radiographs from birth to the late teens or beyond, however those views taken a routinely during the course of orthodontic diagnosis & treatment can be used to study the effects of growth & treatment.

Evaluating cephalometric radiographs:

Before starting a tracing it is important to examine the radiograph for any abnormalities or pathology. For example, a pituitary tumour could result in an increase in the size of the sella turcica. A lateral cephalometric view is also helpful in assessing the patency of the airway, as enlarged adenoids can be easily seen.

✓ ***Hand tracing:***

- Proprietary acetate sheets are the best medium as their transparency facilitates landmark identification.
- A sharp pencil should be used.
- The acetate sheet should be secured onto the film with masking tape, which does not leave a sticky residue when removed.

- The tracing should be oriented in the same position as the patient was when the radiograph was taken, i.e. with the Frankfort plane horizontal.

- For landmarks which are bilateral (unless they are directly superimposed) an average of the two should be taken.

✓ Digitizing:

Information from a conventional hard copy lateral cephalometric film can be entered into a computer by means of a digitizer which comprises an illuminated radiographic viewing screen which is connected to the computer and a cursor used to record the horizontal and vertical (x, y) co-ordinates of cephalometric points and bony and soft tissue outlines. For digital radiographs the points can be entered directly by a mouse click. Specialized software can then be employed to utilize the information entered to produce a tracing and/or the analysis of choice. Studies have shown digitizing to be as accurate as tracing a radiograph by hand.

Cephalometric analysis: general points

The orthodontic literature is replete with different cephalometric analyses, which in itself suggests that no single method is sufficient for all purposes and that all have their drawbacks.

Cephlometric analysis is often based upon comparing the values obtained for certain measurements for a particular individual (or group of individuals) with the average values for their population (e.g. Caucasians). Cephalometric analysis is also of value in identifying the component parts of a mal-occlusion and probable etiology factors, it is useful when a tracing is finished to reflect why that individual has that particular mal-occlusion. However, it is important not to fall into the trap of giving more credence to cephalometric analysis than it actually merits- it should always be remembered that it is an adjunctive tool to clinical diagnosis, and differences of cephalometric values from the average are not in themselves an indication for treatment, particularly as variations from normal in a specific value may be compensated for elsewhere in the facial skeleton or cranial base. In addition, cephalometric errors can occur owing to incorrect positioning of the patient and incorrect identification of landmarks.

Cephalometric norms for Caucasians (Eastman stander):

Measurements	*Mean value*
SNA	81˚
SNB	78˚
ANB	3˚
Upper incisor to maxillary plane	109˚
Lower incisor to mandibular plane	93˚
Inter incisal angle	135˚
MMPA	27˚

Commonly used cephalometrics points and reference lines

Point A: is the point of the deepest concavity on the anterior profile of the maxilla. It is also called the "subspinale".This point is taken to represent the anterior limit of the maxilla and is often tricky to locate accurately. However, tracing the outline of the root of the upper central incisor first and shielding all extraneous light often aids identification. The (A) point is located on alveolar bone and is liable to changes in position in tooth movement and growth.

Point B: the point of deepest concavity on the anterior surface of the mandibular symphysis. B point is also sited on alveolar bone and can alter with tooth movement and growth.

Nasion (N): the most anterior point on the frontonasal suture. When difficulty is experienced locating nasion, the point of deepest concavity at the intersection of the frontal and nasal bones can be used instead.

***Anterior nasal spine (ANS)*:** this is the tip of anterior process of the maxilla and is situated at the lower margin of the nasal aperture.

Anatomical Porion (Pr): The uppermost outermost point on the bony External Auditory Meatus. This landmark can be obscured by ear posts of the cephalostat, and advocate tracing these instead. However, this is not recommended as they do not approximate to the position of the external auditory

meatus. The uppermost surface of the condylar head is at the same level, and this can be used as a guide where difficulty is experienced in determining Porion.

Posterior Nasal Spine (PNS): this is the tip of the Posterior Nasal Spine of the maxilla. This point is often obscured by the developing third molars, but lies directly below the Pterygomaxillary fissure.

Sella (S): the midpoint of the Sella Turcica.

SN line: this line, connecting the midpoint of Sella Turcica with Nasion, is taken to represent the cranial base.

Frankfort plane: this is the line joining Porion and Orbitale. This plane is difficult to define accurately because of the problems inherent in determining Orbitale and Porion.

Mandibular plane: the line joining Gonion and Menton. This is only one of several definitions of the mandibular plane, but is probably the most widely used.

Maxillary plane: the line joining Anterior Nasal Spine with Posterior Nasal Spine. Where it is difficult to determine ANS and PNS accurately, a line parallel to the nasal floor can be used instead.

Antero-posterior skeletal pattern:

Angle ANB

In order to be able to compare the position of the maxilla and mandible, it is necessary to have a fixed point or plane. The skeletal pattern is often determined cephalometrically by comparing the relationship of the maxilla and mandible with the cranial base by means of angles SNA and SNB. The difference between these two measurements angle ANB is classified broadly as follows:

ANB < 2˚ Class III

2˚ < ANB <4˚ Class I

ANB >4˚ Class II

However, this approach assumes (incorrectly in some cases) that the cranial base as indicated by the line SN, is a reliable bases comparison & that points A & B are indicative of maxillary and mandibular basal bone. Variations in the positions of Nasion can also affect angles SNA & SNB & thus the difference ANB; however, variations in the positions of Sella do not. If SNA is increased or

reduced from the average value this could be due to either a discrepancy in the position of the maxilla as indicated by point A or Nasion.

Vertical skeletal pattern:

Again there are many different ways of assessing vertical skeletal proportions. The more commonly used include the following:

• The Maxillary–Mandibular Planes Angle. The average angle between the maxillary plane and the mandibular plane (MMPA) is 27 ±4°.

• Frankfort Mandibular Planes Angle (FMPA). The average angle is 28 ±4°. However, the maxillary plane is easier to locate accurately and is therefore more widely used.

Incisor position:

The average value for the angle form between the upper incisor & the maxillary plane is 109˚. The average value for lower incisor angle is 93˚ for an individual with an average MMPA 27˚. However, there is a relationship between the MMPA & the lower incisor angle: as the MMPA increase, the lower incisors become more retroclined.

Soft tissue analysis:

The major role of analysis of the soft tissues is in diagnosis & planing prior to orthgnathic surgery. As with other elements of cephalometric analysis, there is a large number of different analysis of varying complexity.

The more commonly used is:

Rickett's E-plane:

This line joins soft tissue chin & tip of the nose. In a balanced face the lower lip should lie 3mm behind this line with the upper lip position a little further posterior to the line, however the lip position (upper or lower) could be vary according to the age,sex and nation.

Assessing growth and treatment changes:

The advantage of standardizing lateral cephalometric radiograph is that: It is then possible to compare radiographs either of groups of patient for research purposes or of the same patient over time to evaluate growth & treatment changes. In some cases it may be helpful to monitor growth of a patient over time before deciding upon a treatment plan, particularly if unfavorable growth would result in a malocclusion that could not be treated by orthodontics alone. During treatment it can be helpful to determine the contributions that tooth movements & /or growth have made to the correction & to help ensure that, where possible, a stable result is achieved, for example in a Cl II division 1 malocclusion, correction of an increased overjet can occur by retroclination of the upper incisors & or proclination of the lower incisors &/or forward growth of the mandible or restraint of forward growth of the maxilla. If the major part of the correction is due to proclination of the lower incisors there is an increased likelihood of relapse of the over jet following cessation of appliance therapy owing to soft tissue pressures. If this is determined before appliances are removed, it may be; possible to take steps to rectify the situation. However, in order to be able to compare radiographs accurately it is necessary to have a fixed point or reference line, which does not change with time or growth. Unfortunately this poses a dilemma, as there are no natural fixed points or planes within the face & skull. This should be borne in mind when interpreting the differences seen using any of the superimposition discussed below.

Cranial base:

The SN line is taken in cephalometric as approximating to the cranial base. However, growth does occur at Nasion, and therefore superimposition on this line for the purpose of evaluating changes over time should be based at Sella. Unfortunately, growth at Nasion does not always conveniently occur along the SN line – if Nasion moves upward or downwards with growth, this will of course introduce a rotational error in comparisons of tracings superimposed on SN. It is more accurate to use the outline of the cranial base as little changes occur in the anterior cranial base after 7 years of age. However, a clear radiograph & a good knowledge of anatomy are required to this reliably.

The maxilla:

Growth of the maxilla occurs on all surfaces by periosteal remodeling for the purpose of interpretation of growth & /or treatment changes the least affected surface is the anterior surface of the palatal vault, although the maxilla is commonly superimposed on the maxillary plane at PNS.

The mandible:

It was noted above that there are no natural stable reference points within the face & skull. Bjork overcome this problem by inserting metal markers in the facial skeleton. Whilst this approach is obviously not applicable in the management of patients, it did provide considerable information on patterns of facial growth, indicating that in the mandible the landmarks which change least with growth are as follows (in order of usefulness):

- ✓ The innermost surface of cortical bone of the symphysis.
- ✓ The tip of the chin.
- ✓ The outline of the inferior dental canal.
- ✓ The crypt of the developing third permanent molars from the time of commencement of mineralization until root formation begins.