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Diagnostic Analyses of Craniofacial Areas in School-Age Children and their Assessment

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Annotation: This article presents the opinions of domestic and foreign scientists on the peculiarities of analysis in the diagnosis of the craniofacial region and their assessment.

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Introduction. Diagnostic records and their analysis.

It is essential to obtain high-quality, uncompromising diagnostic records for further assessment of the craniofacial area, teeth and oral cavity structures, bite or occlusion and facial and jaws proportions. These recordings consist of examination models and occlusion recordings, photographs of the face and intraoral cavity, as well as X-ray recordings. The diagnostic records document the patient's condition prior to treatment and provide additional information necessary to make an accurate diagnosis.

For the evaluation of the occlusion, a set of plaster study models should ideally display all teeth and alveolar processes. This requires that the impression is well extended into the labial/buccal and lingual sulci by producing maximum displacement of soft tissues. Also, for better visualization of asymmetries in the archform and tooth positions, models should be trimmed with a symmetric base. Poor quality study models do not offer adequate valuable diagnostic information. It is important to obtain an occlusal record by registering the patient's wax-bite in habitual occlusion. The clinician should make sure that a gross discrepancy does not exist between this position and the retruded cuspal position. A sagittal discrepancy of 1–1.5 mm is of little significance; however, a discrepancy of greater magnitude or lateral shifts should be carefully recorded by obtaining centric relation (CR) bite registration. Study model analysis is a three-dimensional evaluation of the maxillary and mandibular dental arches, the occlusion and the determination of the degree of malocclusion. It must be correlated with other important diagnostic criteria, like cephalometric analysis and radiographic analysis. Certain relationships between arch width, length and mesiodistal tooth material have been expressed by various indices of Ton, Pont, Linder, Harth and Korkhaus. In modern orthodontic diagnosis, these methods are generally considered to be of minimal diagnostic value; however, they are still widely used in most of the orthodontic practices and institutions.

Archform analysis

1. The maxillary arch width in the premolar and molar regions should be assessed to determine, if it is narrow, normal or broad. These values depend on the combined mesiodistal widths of the four upper incisors (SI).

   Pont Index

Maxillary arch width (premolar region) SI x 100 / 80 arch width (mo - Maxillary lar region) SI x 100 / 64 and Harth m - Linder odification SI x 100 / 85 and SI x 100 / 64 - - for the arch width in premolar and molar regions, respectively The values thus obtained indicate the ideal values of premolar and molar widths. The actual measured values of the interpremolar (mesial occlusal pit of first premolars on either side) and intermolar (mesial occlusal pit of first molar on either side) widths are compared to the ideal values to conclude whether the arch is narrow, normal or broad.

2. To assess the adequacy of the arch perimeter from molar to molar, to accommodate an existing tooth material or to assess the degree of discrepancy, Carey's analysis for the mandibular arch and arch perimeter analysis for the maxillary arch are used. The arch length mesial to the first molars is measured by using soft brass wire that is placed on the occlusal surfaces over the contact points and the incisal edges. This is the measured arch length. The total tooth material is calculated by adding the individual mesiodistal widths of the teeth mesial to the first molars. When the measured arch length and the total tooth material are compared, if the discrepancy is less than 2.5 mm, the case should be treated nonextraction; if it is between 2.5 and 5 mm, second bicuspids should be extracted; and if the discrepancy is above 5 mm, first bicuspids are extracted.
3. To assess basal arch width and length of the maxilla and to determine the treatment modality, extraction or expansion, based on the degree of dental arch width, Ashley Howe's analysis is used.

Ashley Howe's index

CFD x 100 / TTM , where CFD is the canine fossa distance and TTM is the total tooth material. If the ratio is less than 37%, extractions are required to resolve the discrepancy; if it is between 37% and 44%, the case is borderline; and if the ratio is more than 44%, no extractions are required.

Mixed dentition analysis Mixed dentition analysis is useful to estimate the size of unerupted permanent teeth to calculate the space available. The information procured assists treatment planning in cases with intra-arch discrepancy (crowding, rotations, etc.) and in those requiring interarch occlusal adjustments. Despite numerous suggested methods, they basically fall into two types:

1. Methods involving measurements from radiographic images
2. Methods involving use of prediction tables, for example, Moyers' prediction tables and Staley–Kreber graph.

Each method has its disadvantages and advantages. Accuracy, ethnic variations and ease of application need to be prime considerations while selecting a method. The author finds the following two methods to be reasonably accurate, easy and clinically useful.

1. Measurement of teeth on radiograph: A good quality, undistorted periapical radiograph is essential. The magnification on the radiograph can be accounted for by simply measuring another erupted tooth and applying the following proportionality equation:

Actual Radiographic width of primary molar width of primary molar equal to Actual width of un 5 erupted premolar Radiographic width of unerupted premolar.

This method can be used in either arches and in all ethnic groups. 2. Tanaka and Johnston method: The width of the lower incisors is used to estimate the width of the unerupted canines and premolars. The method has a slight bias towards overestimating the unerupted tooth sizes.

Tanaka and Johnston Prediction Values:

One-half of the mesiodistal width of the four lower incisors + 10.5 mm equal to estimated width of mandibular canine and premolars in one quadrant.

One-half of the mesiodistal width of the four lower incisors + 11.0 mm equal to estimated width of maxillary canine and premolars in one quadrant.

Radiographic records and their analysis form an integral part of orthodontic diagnosis. A routine clinical examination should be followed by obtaining necessary radiographs to confirm certain clinical findings and to generate additional information to establish an accurate diagnosis. As a part of routine examination, two types of radiographic records are required: panoramic, periapical and occlusal views to provide information regarding the condition of the teeth, bony structures, abnormal position of teeth, etc. and cephalometric radiographs to evaluate malocclusion with respect to facial proportions, components involved and their inter-relationships.

A panoramic radiograph is valuable for orthodontic evaluation at any age. It provides a broader spectrum of views sufficient enough to show any pathologic lesions and supernumerary or impacted teeth. Trabecular pattern, bone loss, caries, developmental status of the teeth, etc. can be easily assessed, and the areas that require a detailed view with intraoral periapical radiographs can be identified. It is certainly a valuable tool for the screening examination to generate adequate information for the clinician to make crucial initial decisions. A series of intraoral periapical radiographs is essential for an adult patient with periodontal disease. For patients with impacted teeth or malposed unerupted teeth, intraoral occlusal radiograph is indicated to determine their exact location. For children and adolescents, bitewing radiographs may be required for a thorough assessment of interproximal caries. The basic principle of radiologic examination is to obtain maximum information with a minimum radiation exposure.

An analysis of the lateral cephalometric radiograph is one of the valuable tools used in orthodontic diagnosis and craniofacial research. With the help of various linear and angular measurements, both sagittally and vertically, it is possible to localize the malocclusion, assess the configuration of the facial skeleton, ascertain the extent of jaw bases and their inter-relationship, assess the soft tissue morphology, identify the growth pattern and direction, evaluate the axial inclination of incisors, analyze the post-treatment changes and define the treatment possibilities and limitations. As a clinician, it is important not to establish the diagnosis solely based on the lateral cephalometric analysis as it lacks information on certain important criteria, like transverse discrepancies, functional relationships and soft tissue dynamics.

Clinical examination is useful in assessing the facial proportions and jaw relations along with the soft tissue drape in all three planes of space. However, accurate quantification of size, position and orientation of the jaws, teeth and the soft tissues is possible only with cephalometric assessment. The information generated from cephalometric analysis helps in pinpointing the problem areas, which is essential in arriving at accurate diagnosis and establishing a detailed treatment plan. In fact, the data, on numerous occasions, also helps predict the prognosis for a case.

Systematic approach to cephalometric analysis should include assessment of:

- Cranial base
- Skeletal maxilla
- Maxillary dentoalveolar region
- Mandibular dentoalveolar region
- Skeletal mandible
- Maxillomandibular relation
- Soft tissues of the face

Cranial base assessment Growth of the cranial base, though appears to be remote from the orthodontist's primary concern, influences the height and depth of the upper face and position of the upper teeth during orthodontic treatment. It is essential to assess the anterior and middle cranial fossa length and flexure. Since the anterior and middle cranial fossae are related to the maxilla and the mandibular ramus, respectively, when they are of average length, an average length of the maxilla and the mandibular ramus is normal and expected. When the cranial fossae are shorter or longer, a corresponding change in the maxilla or ramus height may be considered normal. A greater flexure of the cranial base or smaller saddle angle will lead to an increased predisposition to skeletal Class III relationship despite normalsized maxilla and mandible. Similarly, a decreased cranial base flexure or larger saddle angle will lead to greater probability of a Class II jaw relationship, even if the jaws are of normal size.

No. Parameters Mean female Mean male

1. Ar-Ptm 32.8 +- 1.9 mm 37.1 +- 2.8 mm
2. Ptm-N (parallel to HP) 50.9 +- 3.0 mm 52.8 +- 4.1 mm
3. Saddle angle (N-S-Ar) 123° +- 5°
4. Articular angle (S-Ar-Go) 143° +- 6

Maxillary skeletal assessment

The skeletal component of the maxilla should be carefully assessed in relation to its length, sagittal and vertical positions and rotational pattern. After determining the effective maxillary length, the clinician should evaluate its sagittal position relative to the cranium, as even a normal-sized jaw may be protrusive or retrusive, if it is positioned anteriorly or posteriorly. The cephalometric assessment should include the identification of vertical component contributing to the malocclusion, as it influences the sagittal jaw position. Therefore, the vertical position of the maxilla and the inclination of the palatal plane should be evaluated.

No. Parameters Mean female Mean male

ANTEROPOSTERIOR

1. SNA (Steiner's) 82° 82°
2. N to A (parallel to HP) (Burstone) 0 +- 3.7 mm 2 +- 3.7 mm
3. Effective maxillary length (Co-A) (McNamara) 91.0 +- 4.3 mm 99.8 +- 6.0 mm
4. PNS-ANS (Burstone) 52.6 +- 3.5 mm 57.7 +- 2.5 mm
5. VERTICAL
6. N-ANS (perpendicular to HP) 50.0 +- 2.4 mm 54.7 +- 3.2 mm
7. N-PNS (perpendicular to HP) 50.6 +- 2.2 mm 53.9 +- 1.7 mm
8. Angle of inclination (Pn-Pal) (Schwarz) 85° 85°

Maxillary dentoalveolar assessment

The inclination and position of the dental units in each jaw should be assessed relative to the facial plane and the jaw base itself. The anteroposterior extent of the maxillary alveolar process relative to the cranial base should be determined. To differentiate a skeletal problem from a dental problem, it is critical to assess the inclination and sagittal position of the maxillary incisors relative to both the maxillary skeletal base and the cranium. The vertical position of the incisal edge and the first molar cusp tip relative to the nasal floor should be assessed to identify any dentoalveolar excess or deficiency. An assessment of the dental arch length posterior to the maxillary first molar is done to evaluate the amount of alveolar arch length available for molar distalization mechanics. This analysis is done relative to the pterygomaxillary fissure and is useful when contemplating maxillary molar distalization.

Mandibular skeletal assessment

A cephalometric evaluation of the mandible should involve the analysis of its morphologic and positional variations, in addition to the evaluation of the effective length of the body, chin and vertical ramus; the sagittal mandibular position should be assessed relative to the cranium (N) and the facial plane (N-Pg). The gonial angle configuration is another important parameter that gives a fair indication of morphologic growth pattern of the mandible. The assessment of the inclination of the mandibular base relative to the cranium is done using various reference planes.

No. Parameters Mean female Mean male

ANTEROPOSTERIOR

1. SN-B (Steiner's) 80° 80°
2. N to Pg (parallel to HP) (Burstone) – 6.5 +– 5.1 mm – 4.3 +– 8.5 mm
3. Effective mandibular length (Co-Gn) 120.2 +– 5.3 mm 134.3 +– 6.8 mm
4. Go-Pg 74.3 +– 5.8 mm 83.7 +– 4.6 mm
5. B-Pg 7.2 +– 1.9 mm 8.9 +– 1.7 mm VERTICAL
6. MP-HP (angle) 24.2° +– 5.0° 23.0° +– 5.9°
7. FMA (FH-MP) (Tweed's) 25° 25°
8. SN-Go-Gn (Steiner's) 32° 32°
9. Ar-Go 46.8 +– 2.5 mm 52.0 +– 4.2 mm
10. Gonial angle

Upper 52°–5° 52°–5°

Lower 70°–5° 70°–5°

Total 130° +– 7° 130° +– 7°

Maxillomandibular relation

After the maxilla and mandible have been assessed individually, it is critical to evaluate their relationship to each other. It is the relative position of the jaws to each other that determines a Class I, Class II or Class III malocclusion and facial types. The lower anterior face height is a representation of the sum of the anterior dentoalveolar heights of the two jaws and skeletal base inclination. The facial convexity is determined by the relative position of the cranium (N), maxilla and mandible to each other. To predict the probable direction and pattern of future facial growth, the growth axis (Y-axis) and facial pattern (Jarabak's ratio) should be assessed. The cranial base flexure, glenoid fossa inclination and gonial angle of the mandible together provide valuable information in the prediction of the growth pattern, horizontal or vertical, of the jaws.

Soft tissue analysis

As the orthodontic treatment influences the position of teeth and jaws, which in turn influences the morphology of the overlying facial soft tissues, the evaluation of the soft tissue components of the face plays an important role in diagnosis and treatment planning.

1. The nose morphology, position and size, though cannot be directly influenced by orthodontic or orthopaedic intervention, have a significant bearing on the overall facial appearance. Hence, its various parameters demand careful evaluation.
2. The nasolabial angle is determined by the tip of the nose and the prominence of the upper lip. The assessment of a deviation from normal nasolabial angle should be done by individual evaluation of either factors by drawing a true horizontal line through sub-nasale. Nasolabial angle helps determine prominence of the upper dental units and upper lip and is an important factor to be considered when contemplating amount of anterior dental retraction.

3. The length of the lips influences the incisal show at rest and during function (smiling). This is a very critical factor in designing anterior intrusion and retraction mechanics.
4. The assessment of the overall maxillary and mandibular prominence (jaws, teeth and soft tissue drape) plays an important role in planning sagittal orthodontic or orthopaedic correction.
5. The upper lip thickness and strain factor, if any, should be calculated. Thicker lips follow tooth movement less closely as compared to thin lips. The upper lip strain needs to be eliminated by equivalent incisal retraction for the lips to assume normal form and thickness.
6. The prominence of the lips is assessed relative to various reference lines. Appropriate lip prominence is essential for good facial balance.

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