Global Science Research Journals Available Online at
www.globalscienceresearchjournals.org

ISSN- 2449-1918 Vol 3(1)

Review Article OpenAccess

Assessment and Analysis in Orthognathic Surgery: A Review Article

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Received 25 August 2021; **Accepted** 8 September, 2021; **Published** 15 September 2021

ABSTRACT

In its simplest definition 'Orthognathic surgery' refers to the 'alignment of jaws'. Orthognathic" originates from the Greek words "Ortho" meaning to straight and "Gnatho" meaning jaw. It is possible to correct deformities separately in the midface or the mandible with many types of surgical techniques. Orthognathic Surgery is the art and science of diagnosis, treatment planning, and execution of treatment by combining orthodontics and oral & maxillofacial surgery to correct musculoskeletal, dento-osseous, and soft tissue deformities of the jaws and associated structures.

Keywords: Orthognathic surgery, oral and maxillofacial surgery.

INTRODUCTION

When correction of these deformities is contemplated, esthetic and functional improvement must be considered. New surgical procedures that permit repositioning of jaws and dentoalveolar segments to almost any desired location have been devised. Concurrently, oral surgeons and orthodontics have become more aware of the interrelation of their disciplines. Surgical treatment does not replace orthodontic treatment of severe dentofacial deformities, but complements it. Failure to recognize major functional and aesthetic problems may lead to compromise, complications and unfavorable outcomes. So, analysis of the morphologic form of the face, the soft tissue envelope, and the underlying facial skeleton integrated with the dentition is done [1]. To synthesize the various treatment possibilities into a rationale plan that gives maximum benefit to the patient. Every soft tissue factor cannot be changed, therefore reoccurrence of the problems treated can be expected. Hence Orthognathic surgery has its

own limitations. The role of orthodontist is to align the teeth relative to the upper and lower jaws. And the role of oral & maxillofacial surgeon is to move the facial skeleton.

LITERATURE REVIEW

Patient's personal data Name, age, gender, race, body type, occupation, hair, habit, physical development, any allergy, systemic disease (especially neurological, respiratory and cardiovascular), previous surgery etc. Understanding the patient's concerns, motivations and expectations will help to define treatment parameters and provide information about psychological health of the patient. Upper third of face–can be marked by an appropriate hair style. Deformities in this area indicate craniofacial deformities. The line should form a smooth, continuing curve. An interruption in the curve may be an indication of an apparent skeletal deformity [2]. A clear interruption in the maxillary area indicates maxillary anteroposterior deficiency. The interruption in lower curve is because of mandibular anteroposterior excess.

Upper 3rd of face: The supra orbital rims normally projects 5-10 mm from the most anterior projection of the globe of the eye.

Middle 3rd of face: The nose, cheeks and paranasal areas are sequentially evaluated.

Nose: The shape of the nasal dorsum is noted as normal, convex or concave. The projection of nasal bridge should be anterior to the globe of eye (5-8 mm). The appearance of nasal tip is evaluated for the presence of a supratip break and for tip definition and projection. The general shape of the alar base should resemble an isosceles triangle with lobule neither too broad nor too narrow. The lateral orbital rim lies 8-12 mm behind the most anterior projection of globe [3]. The cheek bone – nasal base – lip curve contour should be a smooth, continue curve with no interruptions, as interruption in the curve may indicate an apparent skeletal deformity. The projection of nose is measured horizontally form tip of nose to subnasale and from subnasale to alar base crease is 2:1. Include evaluations of lips, labiomental fold, nasolabial angle, and chin and chin throat area. The protrusion, retrusion and soft tissue thickness of each lip is evaluated with the lips in repose. The upper lip usually projects slightly anterior to lower lip. The anteroposterior position of the lip may be assessed with the help of the subnasale-pogonion line, also called the lower facial plane

Labiomental fold: the lower lip-chin contour should have a gentle S curve, with a lower lip – chin angle at least 130°. Acute angle indicates class II mandibular antero/posterior deficiency. The flattened angle indicates microgenia or lower lip tension caused by class III malocclusion.

Nasiolabial angle: The nasolabial angle between the inclination of the columella and the upper lip should be 85°-105°. The nasolabial angle will be more in case of mandibular anteroposterior deficiency. The angel will be acute is case of class III relationship.

Chin: The chin should be evaluated in all three dimensions. The width of the chin should be evaluated in relation to the overall facial shape.

Chin throat angle: The presence of a “double” chin and adipose tissue should be noted. The chin-throat angle normally should be 110°. The distance from the neck-throat angle to soft tissue Pog should be approximately 42 mm. Cephalometric analysis can be an aid in the diagnosis of skeletal and dental problems and a tool for simulating surgery and orthodontics. These analyses are primarily designed to harmonize the position of the teeth with the existing skeletal pattern [4]. The lateral and PA cephalometric radiographs are among the most important tools in the diagnosis of jaw deformities. For proper positioning, the patient’s head should be postured so that the jaws are in centric relation with the teeth lightly touching and the lips relaxed. For the lateral cephalometric radiograph, the clinical Frankfort horizontal plane is parallel to the floor. Appropriate intensifying screens should be used so that both hard and soft tissue structures are properly exposed and visible on the radiograph.

Soft tissue pogonion (Pog’) the most anterior point of the soft tissue chin in the midsagittal plane.Soft tissue gnathion the constructed point between soft tissue pogonion and the soft tissue menton; can be located at the intersection of subnasale to soft tissue pogonion line and line from C’ to Me’. Soft tissue menton (Me’) the lowest point on the contour of soft tissue chin, found by dropping a perpendicular line from a horizontal plane through skeletal menton. Cervical point the innermost point between the submental area and the neck located at intersection of lines drawn tangent to the neck and submental areas.

Origin: Introduced by Dr. Cecil C.Steiner in 1953. Cecil Steiner selected what he considered to be the most meaningful parameters and evolved a composite analysis, which he believed would provide maximum clinical information with least number of measurements.

Reference Line: Sella Nasion Line. Dr. Steiner used this as a reference line as these two points were midline points and they move minimally when head deviates from the true profile position.

- The analysis includes:
- Skeletal analysis: relates upper and lower jaw to skull
- Dental analysis: relates upper and lower teeth to their respective jaws & to each other.
- Soft tissue analysis: provides the means of accessing the balance & harmony of lower facial profile.

Mandibular plane angle: It is formed between the mandibular plane (Go–Gn) and the anterior cranial base (S–N) is 32°. The angle interprets the difference between anterior and posterior facial height.

SNA angle: It is formed between the anterior cranial base (S-N) and a line draw through N and A-point. It is 82°. The SNA angle gives an indication of the anteroposterior position of the maxilla relative to the anterior cranial base.

SNB angle: The SNB angle is formed between the anterior cranial base (S-N) and a line drawn through N and B-point. It is 80°. The SNB angle gives an indication of the anteroposterior position of the mandible relative to the anterior cranial base.

ANB angle: The ANB angle is formed between A-N and N-B. It is 2°. The angle provides an idea of the anteroposterior discrepancy between the maxilla and the mandible. In class III Cases, angle is less than 2 degrees, while in class II Cases the angle is increased.

Skeletal vertical relationships:

Mid-face to Lower face skeletal height: skeletal vertical relationships are measured form N to ANS and from ANS to Me. The, distance between N to ANS should be 53 mm, and from ANS to Me is 65 mm. The ratio between midface to lower face skeletal height is 5:6.

The ANS–Me distance will be increased in individual with vertical mandibular excess and open bites. The lower measurement ANS-Me will be decreased in individual with vertical mandibular deficiency and closed bites, deep bites.

Maxillary incisor position: The axial inclination of the maxillary incisors to the NA line is of 22°. The labial surface of the incisor tip should be 4mm anterior to the NA line. Upper incisor angulation is very important is establishing the pre-surgical orthodontic goals.

Mandibular incisor position: The mandibular incisor angulation to NB line should be 25° and the labial surface of incisor tip should be 4 mm anterior to the NB line. It gives an indication of the mandibular incisor's relationship to the mandible.

Occlusal plane angle: It is the angle between the Occlusal Plane (OP) and anterior cranial base (S-N). The mean angle is 14°. High angle means relatively long facial heights, while low angle means vertically short is anterior facial height.

S-Line: According to Steiner, the lips in well balanced position should touch a line extending from the soft tissue contour of the chin to the midline of an S formed by the lower border of the nose. This is called the S-line. If the lips are located anterior to the line then the profile is more convex and when they are behind the line the profile is more concave.

Conclusion: By the above analysis we can conclude whether the maxilla & mandible are prognathic or retrognathic. Dental analysis tells about the axial inclination & placement of both upper & lower incisors.

Posteroanterior cephalometric radiographic evaluation: According to Johan P. Reyneke in addition to lateral cephalometric radiography, individuals with facial asymmetry require posteroanterior radiographic evaluation of the facial bones to complete a three-dimensional facial assessment. It provides clinically relevant information about specific locations and amounts of facial asymmetry.

Transverse posteroanterior cephalometric planes:

Occlusal plane (OP): A plane formed by a line connecting the occluding points of the maxillary and mandibular buccal cusps left and right

Chin plane (CHP): A line drawn on the inferior border of the chin at maximum bone contact, through Me. Vertical posteroanterior Cephalometric line: - It is the geometrically constructed vertical axis GM. It is constructed by dividing the C- plane and the D- plane, connecting these two midpoints, and extending this line to the chin

Triangular Analysis: Triangle is constructed for evaluation of the maxilla, mandible, and chin. The maxillary triangle is constructed by connecting the midpoint of C- plane(C-point) with point J on either side of GM. These connecting lines are called the HR line and the HL line. The base of the triangle is divided in two halves, IR and IL, by GM.

The mandibular triangle is constructed by connecting C-point with Go bilaterally using lines PR and PL. The base of the mandibular triangle is halved into SR and SL by GM. The chin triangle is constructed by connecting the C-point with CHR and CHL; the long legs of triangle are called KR and KL. A line is drawn from B-point perpendicular to CHP to evaluate the mandibular incisor midline in relation to the midline of the chin. The base of this triangle is divided into two halves, GR and GL by GM. By measuring the long legs of the triangles, cants in the maxilla, mandible, and chin can be evaluated in relation to the cranial base, as well as to each other. By comparing the left and right sides of the bases of the triangles, transverse discrepancies on rotation can be assessed [5]. Midline asymmetries of the nasal spine, mention, and dental midlines can be evaluated.

Vertical and transverse dentoalveolar assessment: The vertical relationship between the basal bones and dental and alveolar structures are evaluated by dropping perpendicular lines from J-plane at YR and YL to the occlusal plane and from the Spline to the occlusal plane at ZR and ZL. Transverse discrepancies are assessed by measuring the distance both from YR and YL and from ZR and ZL to GM line. Vertical discrepancies are assessed by measuring the vertical heights from the J-plane to the occlusal plane, comparing left and right-side heights. Mandibular dento-alveolar vertical discrepancies can be examined by measuring the vertical heights from occlusal plane to the S-plane at ZR-ZL.

Patients with relatively long upper lips tends to have less maxillary incisor exposure, while the individual with upper short lips tend to have an increased interlabial gap with increased maxillary incisor exposure. Lower lip / chin length the lower lip / chin length (LLL) is measured from Sti to Me'. It should be 44 ± 2 mm in males and 40 ± 2 mm in females. An increase in the Vertical dimension may indicate an increased anterior vertical height of the mandible while decrease may indicate a short anterior mandibular height.

Interlabial gap: when the lips are relaxed, should just to be touching. An Inter-Labial Gap (ILG) of 1-3 mm is normal. An increased inter-labial gap indicates lip incompetence due to vertical maxillary excess or patient is having a short upper lip.

Maxillary Incisor tooth exposure: when the patient's lips are relaxed, 1-4 mm of maxillary incisors should be visible under the upper lip. Lack of tooth exposure gives an indication of maxillary vertical deficiency or if tooth exposure is more than 4 mm indicate vertical maxillary excess

Soft tissue anteroposterior evaluations:

Nasolabial angle: The nasolabial angle is formed by a line tangent to the columella and a line tangent to the upper lip. A value of 85° to 105° is considered normal. In males the angle is usually more acute, while in females a more obtuse angle. This angle is influenced by position of the upper lip supported by the maxillary incisors and the inclination of the columella of the nose. The angle is more acute in class III cases more obtuse in class II cases. Existing maxillary incisor-upper lip relationship, lip strain, lip thickness, and magnitude of the overjet may influence the nasolabial angle.

Lip Prominence: A line is drawn from subscale to soft tissue pogonion (lower facial plane). The perpendicular distance of the upper lip (Ls) ahead of this line should 3 ± 1 mm, while the lower lip (Li) should be 2 ± 1mm anterior to the Sn–Pog' line. The anteroposterior position of the upper lip is an indication of soft tissue support by the maxillary incisors and plays an important role in orthodontic or surgical positioning of the maxillary incisors. The labral inferior tends to be further ahead of this line (Sn-Pog).

Chin prominence: Evaluated by measuring the distance to a line drawn through N' perpendicular to the FH. This line is also known as 0-degree meridian; Pog' should be 0 ± 2 mm ahead of it. A more prominent chin would be ahead of the 0-degree meridian, while a horizontally deficient chin would posterior to the line. Another vertical line that is helpful in assessing the horizontal prominence of the chin is a line drawn perpendicular to FH through Sn. Pog' should be 3 ± 3 mm behind this line. A horizontally excessive chin would be on or ahead of the vertical line, while a deficient chin would be more than 6mm posterior to this line. Lower lip-chin-throat angle the lower-lip-chin throat angle is contained between a line drawn from Li to pog' and

Lip thickness:

Upper lip thickness is measured horizontally anterior to the bone from 2 mm below A point to the anterior border of the upper lip. Upper lip strain is measured from the vermilion border to the labial surface of the maxillary central incisor and compared with lip thickness above this point. The two measurements above should be within 1 mm of each other. If the distance between the vermilion border and tooth surface is more than 1 mm less than the upper lip thickness, it will indicate upper lip strain, which may be due to maxillary dental protrusion. It's an indication of how far the incisors would have to be retracted for the lip would assume normal form and thickness.

Radiographic Evaluations: Periapical radiographic evaluation: - reveals any kind of periapical pathology or periodontal pathology, dental caries and to assess the deviation of roots in areas of intended interdental osteotomies.

Panoramic Radiographic Evaluation (OPG): Panoramic radiography is an excellent means to establish overview of the paranasal sinuses, bony temporomandibular joint, periapical and periodontal pathology, dental caries, position of the inferior alveolar canal, position of the lingula, position of the mental foramen, tooth root lengths in relation to the maxillary sinus, and mandibular symphysis. Dental model analysis and occlusion analysis Proper dental model analysis is important in the understanding and development of the presurgical orthodontic goals.

Arch length: Evaluation of arch length and cumulative dental width helps identifying the presence or absence of crowding or spacing. It helps to determine whether teeth need to be extracted or spaces need to be created, or spaces need to be closed.

Tooth size Analysis: Relates the relationship of the mesiodistal width of the upper teeth to the lower teeth. This analysis is used in relation to the anterior six maxillary and mandibular teeth. Bolten's analysis is used to correlate the widths of upper anterior six teeth with the lower teeth. The sum of mesiodistal widths of upper anterior six teeth measured at the contact level divided into the combined width of the lower anterior six teeth. Which yield a value called Bolton's index, the average index is 77.5+3.5.

Tooth position: Refers to the angulations of the maxillary and mandibular incisors relative to the basal bone. The tooth position analysis determines whether extractions are necessary, or spaces need to be created or eliminated and which mechanics is needed to align and level the arches.

Arch width Analysis: refers to the evaluation of the intra-arch widths between the maxilla and the mandible. Arch width analysis is helpful is determining presurgical orthodontic mechanics as well as selecting appropriate surgical procedures.

Curve of occlusion: (curve of spee) has significant influence on whether the curve of occlusion in the arches will be corrected orthodontically, whether expectations will be necessary, or whether surgical intervention is indicated.

Buccal tooth tipping:

Evaluates the position of the occlusal surfaces of the maxillary posterior teeth, in a medial or lateral direction. If the occlusal surfaces of maxillary posterior teeth are tipped buccally. It may be very difficult to achieve the occlusion relationship properly. It is even more worsen in the presence of transverse maxillary deficiency with pre–existing buccal tipping. Surgical segmental osteotomy can decrease the curve of Wilson as the palate can be expanded to a greater amount than the occlusal level segment of maxilla can be repositioned in all three planes of space. Missing broken down, or crowned teeth, may influence treatment design. If a tooth is non–restorable and requires extraction in a potential osteotomy location, the exaction space may be needed to be closed orthodontically or the space maintained. In some cases, it may be helpful to maintain the tooth to improve stability during surgical alignment of the jaws or segments with tooth removal post-surgery.

2-Dimensional Cephalometry And Computerized Orthognathic Surgical Treatment Planning:

It is the digital imaging in 2D, which is done with the help of robust cephalometric imaging multitude software packages to rapidly perform the analysis after the establishment of landmarks. It retraces and recalculate the analysis for variety of possible surgical outcomes; however, the predictions depend on accuracy of records, the algorithm specific to the software and the specifics of the patient's population. These programs are designed to allow orthodontic and surgical manipulation with soft tissue responses that are pre-programmed. Imprecise digitization of landmarks will lead to unrealistic soft-tissue morphing results.

Records digitizing stage:

Once the records are of acceptable quality are synchronized. The records now integrated using robust cephalometric imaging software. The cephalometric imaging software has in built anatomical structures which act as templates. Radiographs superimposition is done on these templates. Once the cephalometric landmarks and analysis are completed, the patient's clinical image can be linked to the skeletal framework by correlating the profile on the photograph to the soft tissue profile on the cephalometric film. Generating a visual surgical treatment objective, A final working visual image is produced which is used for treatment planning. Cephalometric and anthropometric measurements derived from the digitized radiographs and overlay soft to hard tissue photographs will be used to guide the treatment direction. Treatment objectives have to be clearly defined before executing treatment.

3D Cephalometric landmark system is integrated into software in the three planes of space (X, Y, and Z). The 3D points positioned on the bone surface. After the anatomical landmarks have been established, then image analysis software will generate projections on the midsagittal plane. This can be compared with 2D Cephalometric analysis and ideal values. The use of software cutting tools allows segmentation of bone, and varying osteotomies can be simulated. The position tools allow the translation and rotation of skeletal elements in 3D space once the bones are segmented. The software also has the capacity to simulate the soft tissue response, and allows the superimposition of soft tissue image over the skeletal framework. Thus, various surgical options can be assessed to achieve an optimal outcome.

CONCLUSION

All of these assessments and analysis helps the surgeons to formulate the best possible treatment for the patient. But all these factors are only a guide towards customization of patient specific treatment algorithm. Also, at all points of analysis patient's chief complaint should also be taken into account, during a treatment planning.

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