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Sassouni Archaeal Analysis (Part 1): Tracing and Scribing the Planes and Arcs

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Abstract: *The purpose of this article is to outline and describe the method of creating and analyzing the Sassouni Plus analysis. The information gleaned from this analysis can be very useful in formulating a treatment plan for our patients. Hopefully some of the misunderstanding and dilemmas can be dispelled regarding this process.*

Introduction

One of the records that is included in the orthodontic standard of care is the cephalometric radiograph. As such, it is for us to determine how to best use this diagnostic tool. The purpose of this paper is to present the analysis known as Sassouni Plus and to suggest its usefulness to the diagnostician. As practitioners of orthodontics, we know that there are hundreds of cephalometric analyses described and in use, and this can present confusion to both beginner and seasoned doctors.

Historically, a quick sketch of Dr. Viken Sassouni may be of value. Dr. Sassouni was described as a scientist, teacher, and mentor.[1] As a faculty member of the University of Pittsburgh, he was a "visionary" focused on 3-D facial dimensions. This forward thinking led him to the development of a cephalometric analysis which has evolved into the analysis known as Sassouni Plus. The Plus includes tweaking by my mentor, Dr. Richard Beistle, who saw the need to add a few details to make the analysis more complete. One of the truly unique features of this analysis is the fact that for the most part, it is not dependant on statistical norms. It is customized to each individual and as such, uses their anatomy to create the analysis. The value of this is that ethnicity, patient's sex, myofunctional habits, dental conditions, etc. are not factors that may skew the results introduced by statistical norms.

Figure 1: Viken Sassouni

Figure 2: Viken Sassoun

Figure 3: Viken Sassouni

The best way to demonstrate this is to go through the analysis and describe each feature. The hope is that this will be beneficial to the reader and perhaps allay some of the confusion in interpreting "cephs." It all begins with a good quality cephalometric radiograph and an accurate tracing. It is then best to work on a rendering of that ceph tracing that is as close to 1:1 as possible. The points then need to be identified and marked

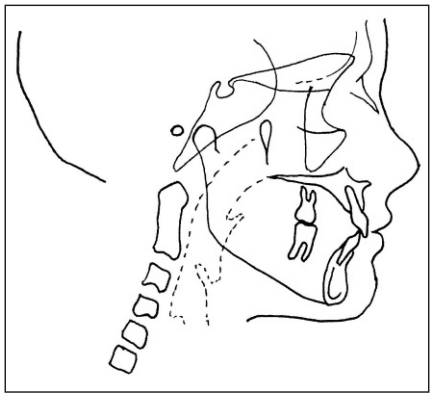


Figure 4: Young patient

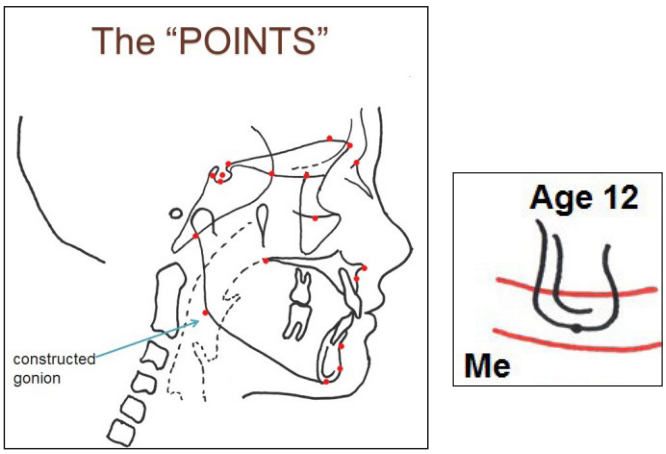


Figure 5: Age 12

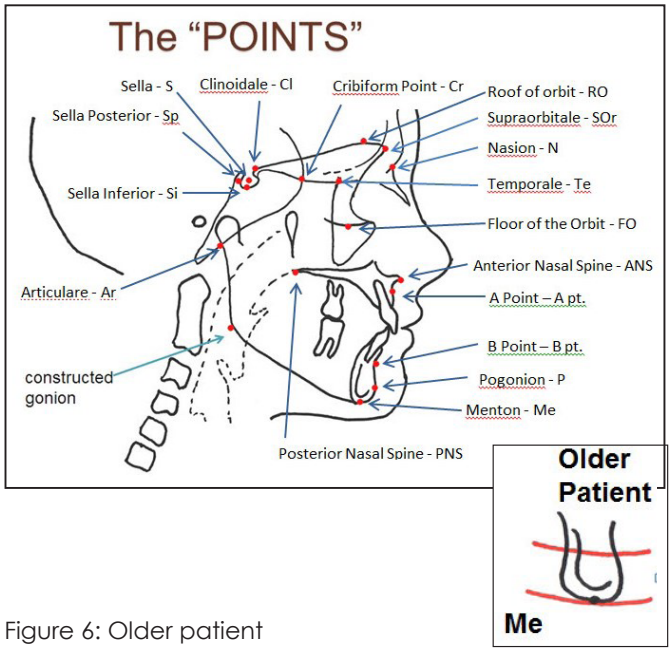


Figure 6: Older patient

correctly. It should also be noted here that with the rendering of 3-D tomography, advances are being made that may well supersede our current methods.

I would like to begin by outlining and identifying the points required for the Sassouni analysis.

Each point will be described:

Roof of the orbit – RO: the most superior point on the upper border of the orbit

Supraorbitale – SOr: The anterior point where the roof of the orbit meets the rim of the orbit

Nasion – N: The point where the frontal bone and the nasal bone meet

Temporale – Te: The point where the anterior wall of the infratemporal fossa intersects with the cribriform plate of the anterior cranial base

Floor of the Orbit – FO: The most inferior point on the floor of the orbit

Cribiform Point – Cr: The point where greater wing of the sphenoid intersects with the cribiform plate of the anterior cranial base

Clinoidale – Cl: The most superior point on the anterior clinoid

Sella – S : The middle point in the sella turcica

Sella Posterior – Sp: The most posterior point on the sella turcica

Sella Inferior – Si: The most inferior point on the sella turcica

Articulare – Ar: The point where the greater wing of the sphenoid intersects with the posterior border of the ascending ramus

Constructed Gonion – G: The point where the inferior border of the mandible plane intersects with a plane tangent to the posterior border of the ascending ramus

Posterior Nasal Spine – PNS: The posterior point on the hard palate. This point is sometimes obscure so a trick to assist in finding it is to use the pterygomaxillary fissure which points basically directly to PNS.

Menton – M: The lowest point on the symphysis of the mandible

Pogonion – P: The most anterior point on the bony chin

B Point – B pt.: The most posterior point on the anterior border of the mandibular symphysis

A Point – A pt.: The most posterior point on the anterior border of the premaxilla. This is another point that is somewhat difficult to see; therefore, a knowledge of anatomy of this area is very useful to identify this point.

Anterior Nasal Spine – ANS: This is the most anterior point on the bony palate and again can be somewhat obscure. As with A pt., knowledge of anatomy in this area is a great asset. This completes the list of points necessary to proceed with the analysis. Accurately tracing the ceph and then correctly marking the points will make the analysis very useful in our diagnostic process. This analysis makes use of planes and arcs that form a pictorial representation of the ceph, and as an extension, the patient. I will begin by identifying the planes. There are 7 of them. They will be individually identified and described.

Supraorbital Plane: This is a plane that passes through the roof of the orbit (RO) and Clinoidale (Cl). This plane is used to help create the optic plane and to establish the parallel plane.

Infraorbital Plane: This is a plane that passes through the floor of the orbit (FO) and sella inferior (Si).

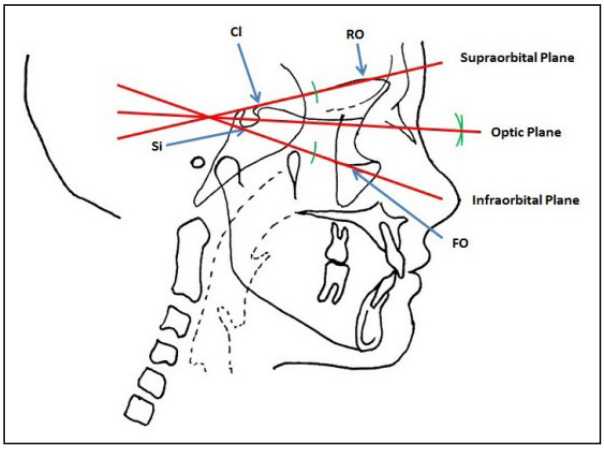
Optic Plane: This is a plane that is a bisection of the angle created by the supraorbital and infraorbital plane. This plane is a fairly accurate representation of horizontal and is equivalent to Frankfort horizontal used in other analyses.

Parallel Plane: This plane is drawn parallel to the supraorbital plane and passes through sella inferior (Si) and is extended to the posterior of the ceph.

Palatal Plane: This plane is drawn through the anterior nasal spine (ANS) and the posterior nasal spine (PNS) and is extended to the posterior of the ceph.

Occlusal Plane: This plane is drawn through the occlusal table of the first molars and the bisection of the incisal edge of the upper and lower anterior incisors and extends to the posterior of the ceph.

Mandibular Plane: This plane is drawn through menton (Me) and follows adjacent to the lower mandibular border extending to the posterior of the ceph.



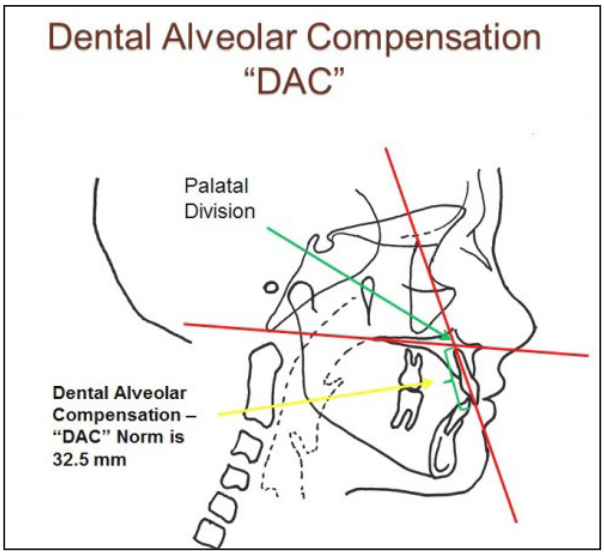
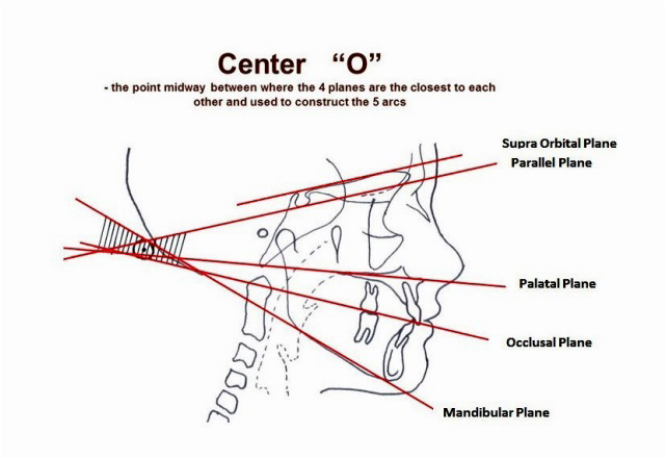


Figure 7: Dental alveolar compensation



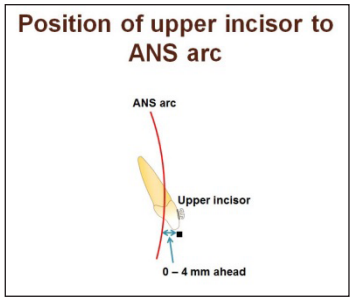
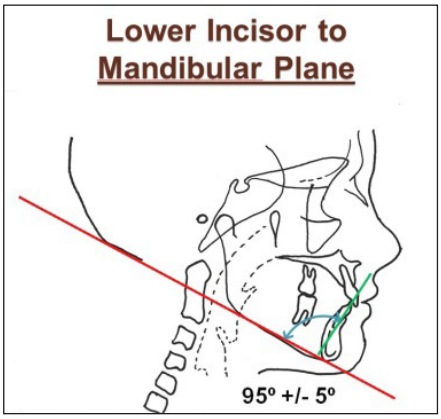


Figure 8: Upper incisor position

The following pictures (Figures 9-13) demonstrate the technique used to bisect the angle between the supraorbital and infraorbital plane to create the optic plane.



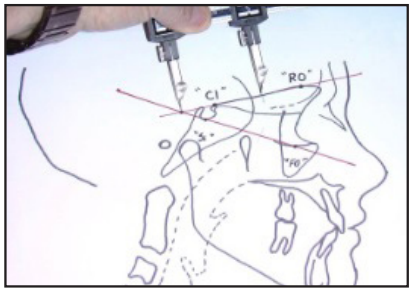
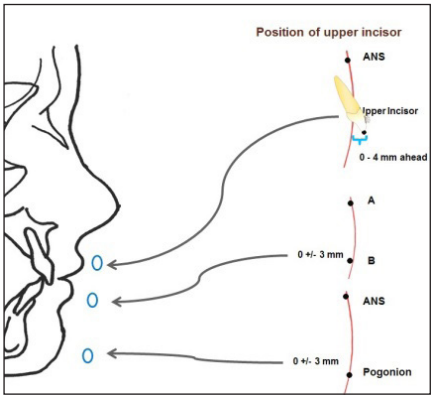


Figure 9: Lower incisor to Madibular plane



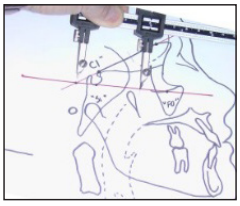
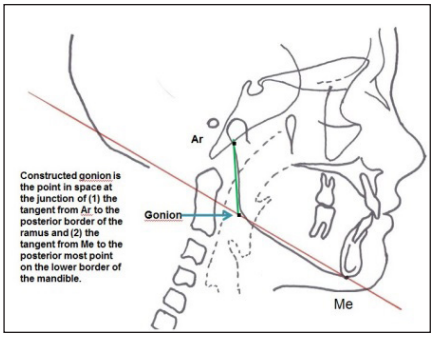


Figure 10: Recording on ceph



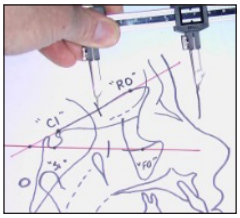


Figure 11: Constructed gonion

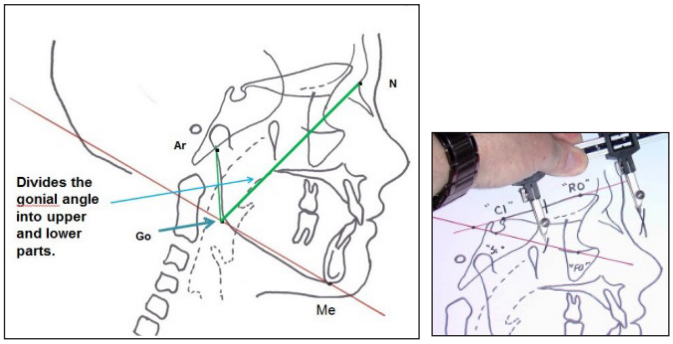
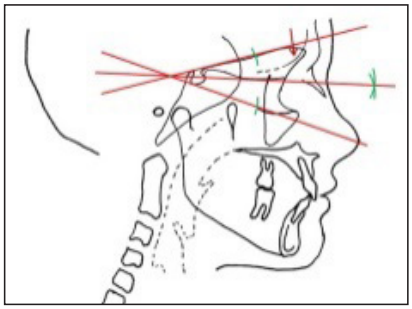


Figure 12: Dividing upper and lower



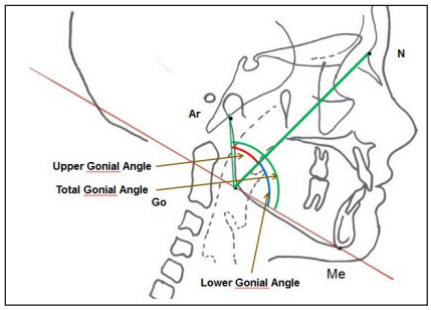


Figure 13: Gonial angles

The next step (Figures 9-13) is to produce arcs which are arguably the most useful component to this analysis. To create the arcs, it is necessary to have a sturdy compass that can be extended to various lengths. I have found that artistic compasses will accommodate this requirement. The one I use is Quint Graphics I159q which works very well.

Divided Gonial Angle

Small Upper	Normal	CW	CW
Normal Upper	CCW	Normal	CW
Large Upper	CCW	CCW	Normal
	Small Lower	Normal Lower	Large Lower

Figure 14: Growth direction chart

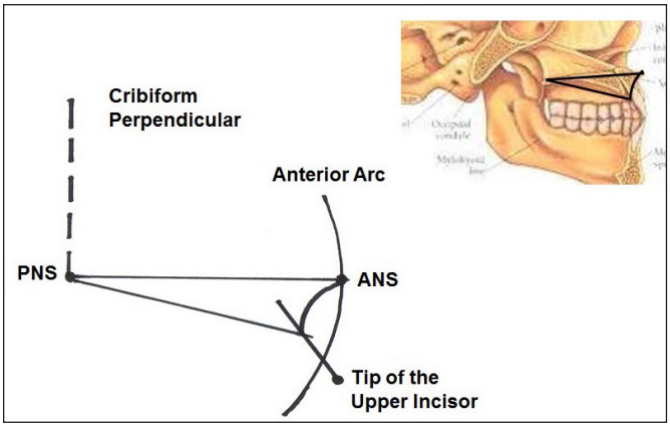


Figure 15: Maxilla analysis diagram

It is first necessary to establish the "Center O" point, which is a point unique to each patient and is used to place the point of the compass when scribing the arcs. This point is in the center of the area where the 4 planes (parallel, palatal, occlusal, and mandibular) are the closest to each other as a group. See Figure 8.

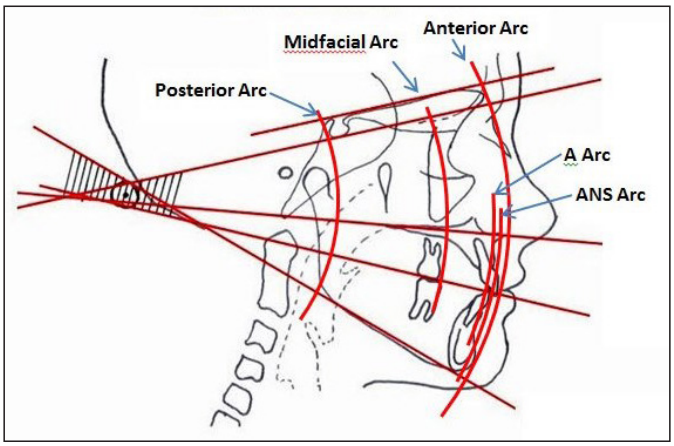
There are 5 arcs scribed using this reference point:
Anterior arc : This arc passes through Nasion (N) and is extended to below the mandibular plane.

ANS arc: This arc passes through ANS and is extended below the mandibular plane.

A arc : This arc passes through A Pt. and is extended below the mandibular plane.

Midfacial arc : This arc passes through Temporale (Te) and extends below the palatal plane.

Posterior arc: This arc passes through Sella posterior (Sp) and extends below the mandibular plane.



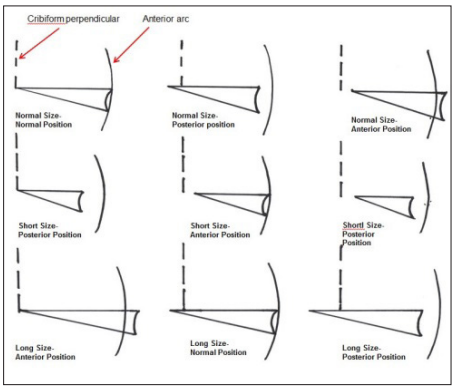


Figure 16: Maxilla variations

There are two more additions to the analysis that aid in interpretation. The first is the vertical analysis. This uses the points, supraorbitale (SOr), ANS, and menton (Me). Arcs are scribed using ANS for the point of the compass. The compass is opened to SOr and locked. A line is scribed through SOr, and then the compass is rotated, and a line is scribed adjacent to Me while the compass is locked at the SOr – ANS dimension. A second line is then scribed 10 mm past that line adjacent to Me.

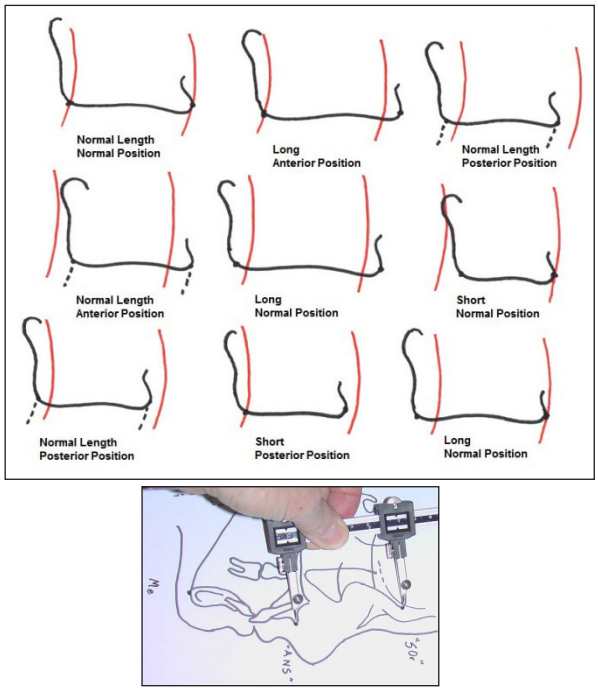
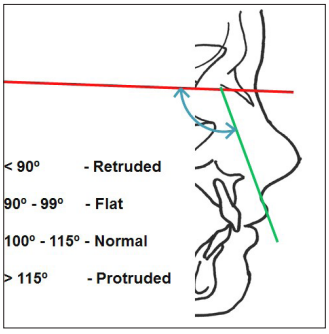


Figure 17: Mandibular variations



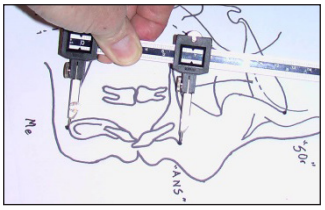
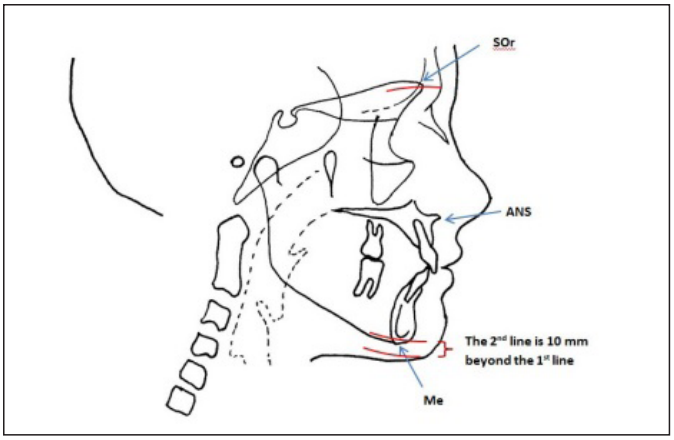


Figure 18: Upper lip angle



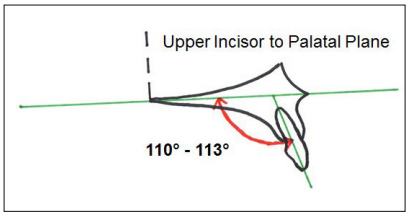
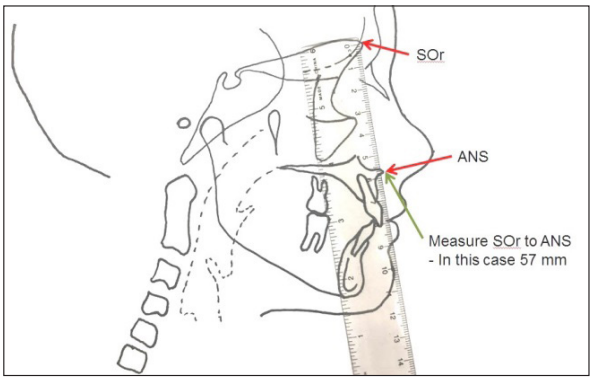


Figure 19: Upper incisor inclination

An alternate method of determining this vertical is to measure from SOr to ANS and then measure down from ANS to Me the same distance and scribe a line. Make a second line 10 mm past this initial line.



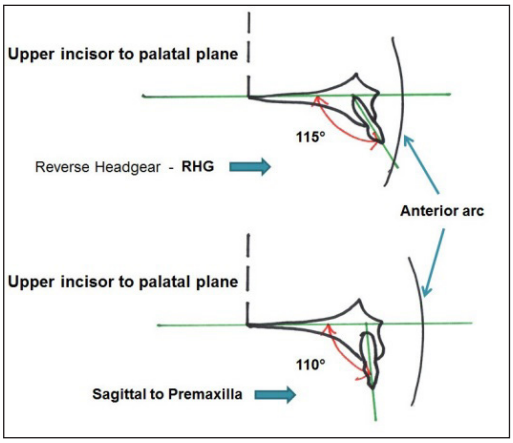


Figure 20: Upper incisor variations

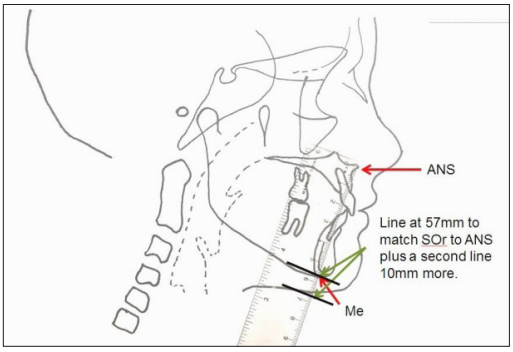


Figure 21: Vertical assessment lines

The final item needed to complete the tracing is a line described as cribiform perpendicular. This is a dashed line drawn perpendicular to the optic plane down from the cribiform point (Cr) to the palatal plane.

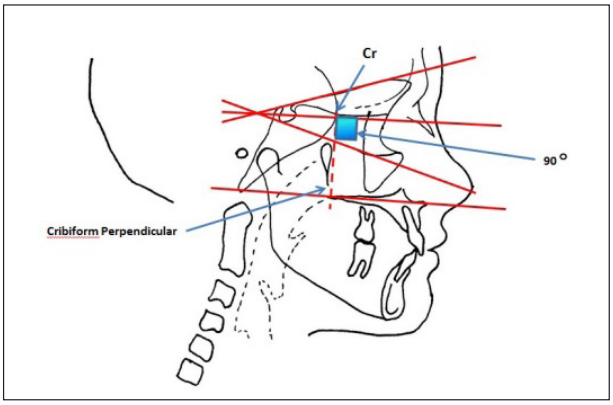


Figure 22: Cribiform perpendicular

The Sassouni archaeal analysis is now complete. In Part 2, we will cover the process for analyzing and using the data now that this section is complete.

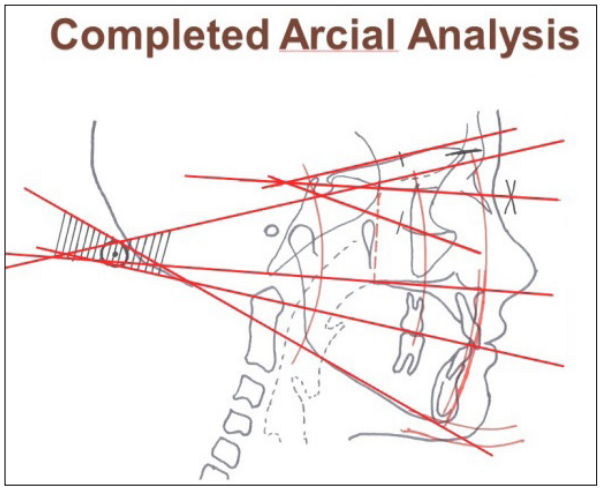


Figure 23: Completed Analysis

References

1. Araújo E. (2015). Viken Sassouni: Scientist, teacher, and mentor. *American Journal of Orthodontics and Dentofacial Orthopedics* 2015;148(4), 540-542.

Sassouni Archaeal Analysis (Part 2): Analyzing the Data

The completed tracing and all the work required to create the archaeal analysis will only have value if the results are understood. The following work sheet is used to record the findings produced by the ceph tracing, and each line will be described and addressed.

NFO Cephalometric "Bottom Line"

- Skeletal---------- I II III IIT IIIT
- Skeletal Vertical---------- N OB DB OBT DBT
- DAC---------- _____MM
- Upper Incisor---------- N P R
- Lower Incisor---------- N P R
- Growth Direction---------- N CW CCW CWT CCWT
- ELP---------- _____MM
- Maxilla Length---------- N L S -- P A
- Maxilla Position---------- N P A
- Upper 6 Position---------- N P A
- Mandible Length---------- N L S -- P A
- Mandible Position---------- N P A
- Upper Lip Angle---------- N P F R
- Upper Incisor to Palatal Plane Angle---------- L LN N HN H

Skeletal AP is determined by relating B point to the A arc and pogonion to the ANS arc. Ideally, B point should fall on the A arc, and P should fall on the ANS arc. Class I range is 0 +/- 3 mm for both B to A arc and P to ANS arc. A skeletal Class II is indicated when *both* B to A arc and P to ANS arc are less than -3 mm. A skeletal Class III is indicated when *both* B to A arc and P to ANS arc are greater than +3 mm. Class I with a class II *tendency* is indicated when B approaches -3 mm to A arc and P approaches -3 mm to ANS arc. Class I with a class III *tendency* is indicated when B approaches +3 mm to A arc, and P approaches +3 mm to ANS arc. Due to the variability of growth in the bony chin button, the relationship of B to the A arc is given slightly more weight than P to the ANS when determining skeletal class of occlusion. If the result is Class I, it can be a true Class I or a Class I with a Class II or Class III tendency, or it can be Class II or Class III. We would circle those values on the appropriate line.

Skeletal----------I II III IIT IIIT

See Figures 1 and 2 for diagrammatic representation of this principle.

We will next describe the evaluation of skeletal vertical. This evaluation makes use of the 2 lines scribed adjacent to Menton (Me), which are 10 mm apart.

Vertically, the lower face height should equal the upper face height at age 4. At age 12, the lower face height should equal the upper face height plus 6 mm. At adulthood in the normal individual, the lower face height should equal the upper face height plus 10 mm. The lower face height from 4 years of age grows approximately ¾ mm per year.

Variations of these norms become diagnostic in evaluating the vertical growth of the patient. We use the diagnostic sheet to record the findings.

Skeletal Vertical----------N OB DB OBT DBT

The vertical will be described as being normal (N), open bite (OB), or deep bite (DB). If the vertical is normal, there

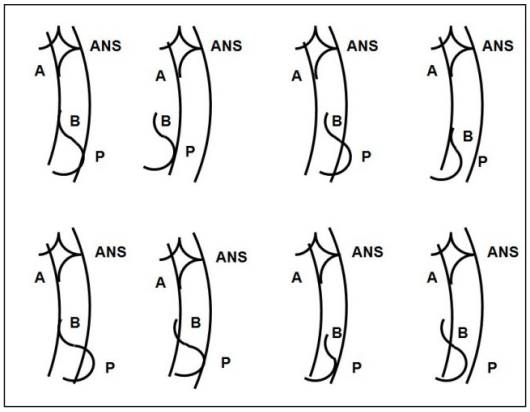


Figure 1: AP variations

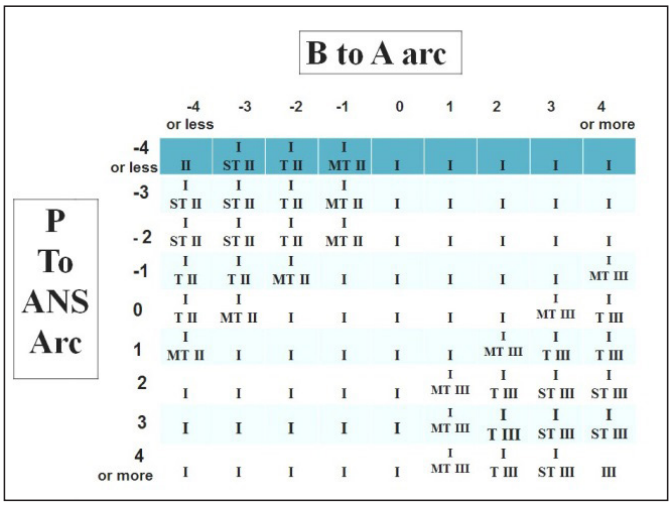


Figure 2: AP chart

Age 4 – LHF = UHF

Age 6 – LHF = UHF + 1.5 mm

Age 8 – LHF = UHF + 3 mm

Age 10 – LHF = UHF + 4.5 mm

Age 12 – LHF = UHF + 6 mm

Age 14 – LHF = UHF + 7.5 mm

Age 16 – LHF = UHF + 9 mm

Adult – LHF = UHF + 10 mm

Figure 3: Age Variations

may be an open bite tendency (OBT) or a deep bite tendency (DBT). In a skeletal deep bite case, it is possible to build up the bite with bite turbos and molar build ups and then erupt teeth. In a skeletal normal or open bite case, this would be contraindicated and would necessitate intrusion of the anterior teeth to correct the deep bite.

Dentoalveolar compensation (DAC) is a measurement from the palatal plane to the tip of the central incisor along the long axis of the tooth. The normal value for DAC is 32.5 mm. This assessment is used to assess the need for extrusion or intrusion of the maxillary incisors.

The next two sections relate to upper incisor tip positions and lower incisor inclination. The upper incisor inclination will be dealt with later in the analysis. They would be either normal(N), proclined(P), or retroclined(R). For the upper incisor the measurement is 0 – 4 mm anterior to the anterior arc. Less than 0 would indicate the upper incisor is retroclined, and more than 4 would indicate a proclined upper incisor. The lower incisor is measured in degrees relative to the mandibular plane, and the normal is 95 +/- 5. Less than 90 degrees would indicate a retroclined lower incisor, and more than 100 degrees would suggest proclination of that incisor. These are recorded on our chart as follows:

Upper Incisor----------N P R

Lower Incisor----------N P R

The values of upper incisor to the ANS arc, Pg to the ANS arc, and B to the A arc can now be recorded on the tracing as follows.

The analysis will next deal with direction of growth. This is accomplished by using gonial angles and then applying ranges to determine and predict growth direction. The gonial angle is created between the mandibular plane and the line tangent to the posterior ascending ramus.

In order to estimate growth direction more accurately, we must go beyond accepting the gonial angle as a single factor of mandibular morphology. The manner in which the ascending ramus and the mandibular body are related to each other to form the gonial angle determines how the mandible will grow. In order to determine the angular relationship in which the ramus and the mandibular body are put together, the gonial angle needs to be divided into two parts. This is done by scribing a line from nasion to constructed gonion. This divides the gonial angle into an upper angle and a lower angle. The upper angle identifies the slant of the ramus, whereas the lower angle identifies the slant of the mandibular body. The normal range of the total gonial angle is 122° - 130°. The normal range of the upper gonial angle is 52°-55°, and the normal range of the lower gonial angle is 70°-75°. If the upper angle is large, the growth will be anterior and conversely; if the upper angle is small, the growth will be posterior, and there will be a downward component (clockwise). If the lower angle is large, the growth will be downward or vertical. If the lower angle is small, the growth will tend to be forward (counterclockwise). There is a chart that will help to clarify this:

In our diagnostic work sheet, the options for growth direction will be normal (N), clockwise (CW), or counterclockwise (CCW). If the growth is normal, there may be a clockwise tendency (CWT) or a counterclockwise tendency (CCWT).

Growth Direction----------N CW CCW CWT CCWT

We will now move into an area referred to as the effective length of the premaxilla (ELP). The palatal division is the intersection of the palatal plane and the line through the long axis of the maxillary central incisor. The ELP is essentially the mm measurement from the palatal division to the ANS along the palatal plane and is normally 13 mm. This separates the premaxilla from the maxilla and gives an indication of the length of the premaxilla. It is affected by the inclination of the central incisors.

ELP----------_____MM

The next two sections, maxilla length and position, are valuable tools in this analysis. These are evaluated using the anterior arc and the cribriform perpendicular. These evaluations use the ANS and PNS to measure the maxilla as per Figure 15.

The position of the maxilla is evaluated by using the ANS relative to the anterior arc. The size of the maxilla is determined by comparing the distance from ANS to PNS relative to the distance from the anterior arc to the cribriform perpendicular along the palatal plane. Figure 16 gives some examples of variations in size and position. A posteriorly positioned maxilla may require mechanics to advance the maxilla such as a reverse pull facemask or a tandem appliance. An anteriorly positioned maxilla would require surgery to position correctly. Fortunately, this is not as common an occurrence. A short maxilla may have trouble fitting a full complement of normally sized teeth, whereas a normal or long maxilla should have sufficient room for normally sized teeth.

On our chart, these values would be recorded as follows. The length would be normal (N), long (L), or short (S). If the maxilla is long or short, it would be either in the posterior (P) or the anterior (A). The position would be either normal (N), posterior (P), or anterior (A).

Maxilla Length----------N L S -- P A
Maxilla Position----------N P A

The Upper 6 position is evaluated using the mid-facial arc. The first step is to determine where ANS is relative to the anterior arc. If ANS is posterior to the anterior arc, the point used is an equivalent distance posterior to the mid-facial arc on the palatal plane. The same applies in the anterior direction, and if ANS is on the anterior arc, then we use a point on the mid-facial arc. The mesial of the upper first molar is then evaluated relative to this point. In the mixed dentition, the first molar is 2 mm posterior to this position to account for the leeway space produced by the 2nd primary molars. The results are then recorded on the form. The result would be normal (N), posterior (P), or anterior (A).

Upper 6 Position----------N P A

The mandible is now evaluated in a similar fashion to the maxilla. For this evaluation, the posterior arc and the anterior arc are used. The relationship of pogonion (P) to the anterior arc is used to evaluate position, and the distance from pogonion to gonion is used to evaluate size. A normal size would be a distance between Pg and G that matches the distance from the anterior arc to the posterior arc. The posterior arc should pass through gonion at age 12. This permits evaluation of the anteroposterior position of gonion. If gonion is located on the posterior arc and pogonion on the anterior arc at age 12, it means that the corpus length is equal to the length of the anterior cranial base (Sp-N), and therefore is of normal length. Before age 12, the corpus is smaller; and, after age 12, it is larger than the anterior cranial base. Shortness of the corpus in the anterior is more influential on the malocclusion and the profile than the same degree of shortness posteriorly. At age 4, gonion should be found 6 mm ahead of the posterior arc. At age 16, gonion should be found 4 mm behind the posterior arc in boys. In the adult, gonion should be found 6 mm behind the posterior arc in males and 4 mm behind the posterior arc in females.

These values are transferred to the diagnostic form the same as those for the maxilla.

Mandible Length----------N L S -- P A
Mandible Position----------N P A

The next evaluation is the upper lip angle. The angle is constructed by drawing a line tangent to the anterior most tip of the upper lip, through the point where the upper lip ends and the nose begins (subnasale), and then by extending it up to intersect the optic plane. The angle between this tangent line and the optic plane is then measured.

The results are then transferred to the diagnostic form. They would be retruded (R), flat (F), normal (N) or protruded (P).

Upper lip angle----------N P F R

The final measurement is the angle of the upper incisor to the palatal plane. This gives an indication of the amount of flexure between the premaxilla and the palate and/or the angulation torque of the upper incisor. It can be useful in determining the treatment needed to advance the upper anterior teeth. The options would be to advance the entire maxilla with mechanics such as a reverse facemask or tandem appliance or to torque the upper incisors with a sagittal type appliance.

The results would be low (L), low-normal (LN), normal (N), high-normal (HN), and high (H) and are not specified with specific numbers other than normal which would be 110° - 113°.

Upper incisor to palatal plane angle----------L LN N HN H

This completes the Sassouni Plus analysis. This information is now combined with the other diagnostic data to create a treatment plan that will be best for the patient. When used in combination with facial analysis and myofunctional health, these tools become a great asset in developing a comprehensive treatment plan that becomes predictable and effective. Remember that these are tools and do not replace the valuable relationship between patient and practitioner and also the value of a practitioner's overall evaluation of each case.

Dr. Lowry had used this analysis since the early 1990s and has taught it to students and colleagues around the world.

Dr. Mike Lowry has been in the practice of orthodontics for over 30 years. He has been with Rondeau Seminars, the United States Dental Institute, and has been associated with various instructors teaching TMD and facial pain including the Facial Beauty Institute and the IAO Instructor's Institute. He is a Master Senior Instructor with the IAO. He has served as president of the IAO and was on the executive committee. He treats all phases of orthodontics including orthopedics and TMD. He is a diplomate of the IAO in the tier advancement program, and also serves as an examiner. He is currently vice-president of the IBO, and he is a mentor for 3 study clubs in Alberta and Vancouver.