Orthodontic Diagnostics: a Modified Sassouni + Cephalometric Analysis


Modern orthodontic diagnostics requires an extensive knowledge of not only occlusion but of craniofacial growth. The study of Cephalometrics is an age old concept advanced by hundreds of orthodontic experts, societies and associations for the purposes of nomenclature, diagnostic and therapeutic treatment planning. The authors have advanced and improved upon the original Sassouni + Cephalometrics to allow for a more neuromuscular functional occlusal, upper airway and craniocervical evaluation of the patient presenting for orthodontic and or occlusal therapy.

Sassouni + was first introduced by Dr. Richard Beistle of Buchanan, Michigan. This analysis had its origin from orthodontist Dr. Viken Sassouni of the University of Pittsburgh. The original was developed in the late 1950’s by Dr. Sassouni for use with the traditional techniques of the time. Sassouni, however was unaware of the usefulness of the analysis in evaluating patients from a European style functional perspective. After Dr. Beistle adapted the analysis, Dr. Jay W. Gerber discovered its importance in the evaluation from a neuromuscular perspective. In 1987 he advanced the diagnosis for a more complete craniomandibular analysis.

Understanding Sassouni +

The following information will allow the treating dentist to better interpret the diagnostic data available in the analysis.
Once the completed analysis in your hands you are well on your way to a successful case diagnosis. So how do you use this information in diagnosis, treatment sequencing and in appliance selection? The analysis is also useful in evaluating TMJ and airway function.

First we will go down the bottom line, item by item, to see how you can make the most use of the advanced Sassouni Plus. (fig 1) The bottom-line first proposed by Dr. Beistle allows one a quick look at the important points of the evaluation.

**CEPHALOMETRIC “BOTTOM LINE”**

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<tr>
<th>SKELETAL A - P</th>
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<tr>
<td>SKELETAL VERTICAL</td>
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<td>DAC</td>
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<td>UPPER INCISOR</td>
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<td>LOWER INCISOR</td>
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<td>GROWTH DIRECTION</td>
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<td>MAXILLA POSITION</td>
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<td>UPPER 6 POSITION</td>
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<td>MANDIBLE LENGTH</td>
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<td>UPPER INCISOR ANGULATION</td>
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Fig. 1
**SKELETAL A-P CLASSIFICATION** - (fig 2) By comparing the dimensionally corrected ‘A’ arc of Sassouni the clinician can determine the relative horizontal relationship of ‘A’ to ‘B’. This illustrates the relative positions of the maxilla and mandible as they relate to one another. Class I is considered normal or the relations of the maxilla to the mandible are normal or balanced. Class II skeletal means the mandible is too retruded or behind the maxilla, while Class III means the mandible is protruded or too far in front of the maxilla, or that the maxilla is deficient and makes the mandible appear prognathic when in fact it may be in a normal relation with the cranial base. The notation ‘T’ found in the “Bottom Line” after the notations indicates a tendency towards a Class II or III. Generally we consider this variance from one millimeter to be mild, while a difference to three millimeters to be of strong tendency toward the skeletal classification. When the discrepancy between the maxilla and mandible (+ or -) reaches seven millimeters, the situation becomes serious, and orthopedic correction will require more time and greater cooperation from your patient. The face will often begin to show obvious distortion from normal proportion at seven millimeters of discrepancy.
When evaluating a patient for treatment it is important to remember that the maxillary-mandibular relationship can be Class I, II, or III with either or both maxilla and mandible being poorly related to cranial base.

**SKELETAL VERTICAL** - Anterior Skeletal Vertical (ASV) is an age sensitive measurement of the skeletal anterior facial height by relating upper to lower facial height. This measurement is critical since vertical skeletal development is essential to stability following treatment. The evaluation is derived by measuring the Supra Orbitale (SOr) to the Anterior Nasal Spine (ANS). This measurement establishes the Upper Facial Height. The arc is completed to evaluate the Lower Facial height to Menton, the lowest point on the mandibular symphysis. This point should be on the upper arc at age four, moving downward until it rests on the lower arc to 2 mm below the lower arc at age seventeen. Movement will be more rapid during growth spurts, which will occur at about six, eight, and twelve years, and earlier in females. Development of full vertical dimension should be a primary goal in treatment.
**ANTERIOR SKELETAL VERTICAL**

Using your RED pencil, place the tip of the compass at ANS, extend to SOr and draw a small arc. By rotating the compass, transfer this dimension to the area of (ME) Menton and draw another short arc. Increase the compass 10 mm and draw a third small arc. The latter two arcs give you the range of vertical normality of the individual patient.

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**UPPER INCISORS** – (fig 4) This horizontal measurement is an indication of the position of the upper incisor tip relative to the arc from anterior nasal spine (ANS). For this to be accurately assessed, the effective length of the Premaxilla must be measured and, if short or long, adjusted using the Palatal Division compensation (fig 5). The position of the incisor tip will be influenced by labial torque of the incisor and by its dentoalveolar compensation (eruption). In an ideal case, the anterior arc from Nasion will fall on the arc from anterior nasal spine. The tip of the incisor should lie on the arc to three
millimeters forward of the arc formed from ANS. The most desirable facial profiles have a +2 or +3 measurement anterior to the arc. Gerber reported that this position also conforms to Neuromuscular Trajectory.

**Dentoalveolar Compensation** – First proposed by Magill the DAC is measured from the point where the long axis of the maxillary incisor crosses palatal plane (Palatal Division), continuing along the long axis to the central incisor tip. In an ideal case, the average length is 32.5mm. This incisor length allows you to better understand if intrusive or extrusive mechanics are indicated, and whether retruded or protruded teeth require a change in torque. As a rule: the more extrusion the more the tooth moves labial. And the more extrusion present the more “gummy” the smile.

The **Palatal Division** (fig 5) provides a logical separation of the Premaxilla from the Maxilla. This is located at the intersection of the Palatal Plane and the Long Axis of the Upper Incisor. The distance measured between the Palatal Division and ANS is the Effective Length of the Premaxilla (ELP). The Dental Alveolar Compensation (DAC) is measured from the Palatal Division to the Incisal Edge along the Long Axis of the Upper Incisor.

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**Lower Incisor**- This is simply the angle of the long axis of the lower incisor to mandibular plane. It is now felt that an angle of 95-102° is much more stable and attractive. This permits the more desirable contact of the lower incisor tip to the lingual surface of the maxillary incisor. Eliminating a labial first-contact that can initiate proprioception of mandibular retrusion.

**Direction of Growth** – (fig 6) is one of the most useful features of the Analysis. To obtain the growth direction, the gonial angle is divided into two compartments. The upper compartment, with a normal angle of 52-55 degrees, is an indicator of horizontal or counterclockwise growth of the mandible. The lower compartment, with a normal angle of 70-75 degrees is an indicator of vertical or clockwise growth. It is important to remember that vertical or horizontal growth does not occur in a straight line.
All growth is curved or arcial which is the genius behind the Sassouni Analysis. It is arcial, and is an analysis that is capable of reflecting growth with any accuracy.

The estimation of the direction of growth is very important in the selection of functional appliances. The Constructed Gonial Angle used in the analysis improves the accuracy to which we can predict. We must go beyond accepting the Gonial Angle as a single factor of Mandibular morphology. The manner in which the Ascending Ramus and the body of the Mandible are related to each other from the Gonial Angle determines how the mandible will grow. When determining this angular relationship, the Gonial Angle is divided into two parts. First, you draw the Facial Depth Line from Nasion to Constructed Gonion. This divides the gonial Angle into Upper and Lower Angles. The Upper Angle identifies the slant of the Ramus whereas the Lower Angle identifies the slant of the body of the Mandible. The normal range of the Gonial Angle is 120° TO 132°. The normal range for the Upper Angle is 52° TO 55° and the normal range for the Lower Angle is 70° TO 75°.

If the upper angle is large, the growth will be forward. If the lower is large the growth will be downward. If the upper angle is small the growth will tend to be downward and backward (CLOCKWISE). If the lower angle is small the growth will be forward (COUNTERCLOCKWISE).

The simplest and most accurate method of determining growth direction is to divide the upper angle by the lower angle. This will give you a percentage. This can then be related to the following chart to find the direction of growth.
70 to 78 per cent = Neutral Growth
69.9 per cent to 68.1 per cent = Clockwise Tendency
68 per cent or less = Clockwise Growth
Less than 60 per cent = Extremely Clockwise Growth
78.1 per cent to 79.9 per cent = Counterclockwise Tendency
80 per cent or more = Counterclockwise Growth
More than 88 per cent = Extremely Counterclockwise Growth

**Maxillary Position** – This relates the position of the maxilla to the cranial base.

Ideally, the maxilla will lie with anterior nasal spine (ANS) on the anterior arc and posterior nasal spine (PNS) on Cribiform Perpendicular. For this to be meaningful, the effective length (ELP) of the Premaxilla must be established. You measure from the palatal division where the long axis of the upper incisor crosses palatal plane, to the anterior nasal spine. The length should be 12 to 15 mm. A short or long Premaxilla
must be adjusted for maxillary position to be accurate. The effective length must be 12 to 15 mm no matter to what degree the incisors are inclined.

In **treatment planning**, it must be kept in mind that maxillary position is different in male and female patients. Male patients can have the maxilla up to four millimeters behind the anterior arc with no harm to facial esthetics. In fact, anterior position of the maxilla “feminizes” the face. In a female patient, the maxilla should be at least at the anterior arc, and, for the best facial esthetics, slightly forward of the arc. (fig 7)

**Upper 6 Position** – This measurement theoretically gives the ideal position of the maxillary first molar. Unfortunately, this measurement is very often useless, and cannot be relied upon to plan treatment.

**Mandibular Position** – Ideally, the mandible will lie between the anterior and posterior arcs at the age of twelve. Pogonion, the most anterior point on the curvature of the mental protuberance, should lie on the anterior arc at all ages. Constructed Gonion, the posterior reference point, should be anterior to the posterior arc before the age of twelve, passing through the arc as the patient ages. In the adult, Gonion should be up to four millimeters distal to the arc in a female, and up to six millimeters in a male. Again, the length of the mental protuberance must be accounted for in the position of the mandible. This should be from six to nine millimeters from B perpendicular. (fig 7)
**Mandibular Length** – The mandible should be equal in length to the distance from anterior arc to posterior arc at the age of twelve. (fig 7) The length of the mental protuberance, from B perpendicular to Pogonion (the most anterior point on the bony chin) should be from six to nine millimeters. The mandible may be long or short anteriorly, posteriorly, or both. The mandible may be of normal overall length while being short on one end and long on the other. The mandible which is long posteriorly may predispose the patient to temporomandibular joint problems, if other factors are present. A long or short mental protuberance may have facial consequences, but there is little which can be done therapeutically to affect this, although good lip balance certainly will improve the appearance in all cases.
**Upper Lip Angle** – This is included in the analysis because it has traditionally been included. We do not feel it has any diagnostic relevance. We would advise ignoring it, and judging lip balance by your patient’s face.

**Upper Incisor Inclination to Optic Plane** – This is the simple angle between the long axis of the upper incisor and optic plane. (Fig 8) Previously this measurement was taken-off of the variable occlusal plane. We now use optic plane because it represents both a stable cranial landmark and the true horizontal reference of the analysis. Palatal plane is adaptive to maxillary and mandibular eruptive occlusal changes and to the anterior maxillary changes brought on by upper airway obstructions.
Cant of the Palatal Plane – the horizontal comparison of the Palatal Plane to Optic Plane gives us diagnostic information concerning the relative pathology underlying the skeletal and dental malocclusion. Figure #8 represents a normal balanced relationship in that the Palatal Plane parallels the Optic Plane.

In a malocclusion we might observe the planes to converge anteriorly, this indicates a lack of normal downward and forward placement the anterior maxilla or the pre-maxilla is tipped upward. The etiology is either an anterior tongue thrust or a ‘finger’ habit. The former may be consistent with Upper Airway Obstruction associated with open mouth breathing.

A second pathological condition would exhibit a Palatal Plane that tips-up in the back or one where the posterior Palatal Plane would converge to intersect the Optic Plane somewhere in the distance. This condition is thought to be brought on by the lack of posterior dental and skeletal growth that is often seen in patients with posterior deep bites. Patients with this condition often have hyper activity of the Masseter Muscles which is often found in TMJ pain and headache patients.

It should be noted that most any anterior or posterior convergence is usually minimal and is only a few degrees (2-3°). The more extreme cases are quite easy to spot.

Summary – This extensively modified version of the Sassouni Cephalometric Analysis is very beneficial to the dentist treating functional orthodontic, airway
obstructed and TMD patients. Some practitioners even derive benefits from its application when determining vertical in the edentulous patient.

The Modified Sassouni + Analysis has been shown to be of great benefit to determine vertical proportion and growth potential of the young patient. The analysis has the ability to show incisor placement relative to opening and closing trajectory used in Neuromuscular Dentistry and where to place the mandible for functional advancement.

Practitioners need a diagnostic cephalogram that is visual and descriptive of the skeletal and dental malocclusion. This analysis provides many tools that will assist the clinician in making those decisions.

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Jay W. Gerber, D.D.S. is the clinical director of the TMJ and Craniofacial Pain Clinic where he provides treatment for orthodontics and TMD in Parkersburg, WV. He is the founder and director of the Center for Occlusal Studies an educational facility in Parkersburg, the Director of Neuromuscular Orthodontics at the Las Vegas Institute and is a Certified IAO Senior Instructor. He has lectured to distinguished groups, associations and at universities since 1984. In 1990 he was honored as the ‘Clinician of the Year’ by the American Association for Functional Orthodontics. Dr. Gerber is the developer of the NFO™ Neuromuscular Functional Orthodontics Gerber Technique and numerous functional orthopedic appliances.
Dr. Richard T. Beistle received his D.D.S. degree from the University of Michigan in 1961. He is a disciple of Doctors Hy Pleasant, Dr. John Wltzig and Merle Bean. He has been a leader in the use and application for cephalometric diagnosis in orthodontics. Dr. Beistle introduced the concept of Sassouni + Analysis in the mid 1980’s and since that time has been an author and popular lecturer on the subject. Since 1987 he has lectured with Dr. Gerber on functional orthopedics and orthodontics.

Mr. Thomas S. Magill has been in the orthodontic arena for over thirty years as a laboratory technician and owner of Frozen Tundra Diagnostics in Minneapolis. Mr. Magill is recognized as an authority on cephalometrics. He is responsible for many progressive updates and changes to the modified Sassouni Cephalometric Analysis including the DAC and the ELP. He has personally traced over 50,000 radiographs and is recognized as an authority on functional diagnosis.

Jay W. Gerber, DDS, FICCMO, FIAO, DAAPM

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