10.5368/aedj.2015.7.3.3.1

CEPHALOMETRIC ANALYSIS FOR ORTHOGNATHIC SURGERY

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ABSTRACT: The key for successful orthognathic surgery is the precise and careful diagnosis of facial, skeletal and dental problems. The cephalometric analysis for orthognathic surgery shows the orthodontist the horizontal and vertical positions of the facial bones by the use of a steady harmonized system. The sizes of the bones are represented by direct linear measurements whereas the shapes are measured by angular measurements. This analysis has been imperative for diagnosis and treatment planning of orthognathic surgery. The landmarks and measurements selected in the analysis can be altered by numerous surgical procedures. The rectilinear measurements can be transferred readily to a case study for mock surgery to learn further. And finally the comprehensive appraisal encompasses all of the facial bones and a cranial base for reference. To make it clinically practical, the analysis has been reduced to its most relevant and significant measurements. Because the measurements in cephalometric analyses are primarily linear, they may be eagerly applied to prediction overlays and serve as a basis for the assessment of other post treatment stability options.

KEYWORDS: Cephalometric analysis, Orthognathic surgery

INTRODUCTION:

Cephalometric analysis performed on the lateral cephalometric radiograph provides details about skeletal structure relationships as well as relationships between skeletal structures and the teeth and facial soft tissues, which cannot be observed in any other way. The catalytic role of such imaging on the complexity of the stomatognathic system and the knowledge of the functional impact of various facial patterns has been included not only in orthodontics but in other fields as well, such as orthognathic surgery. Although cephalometric analysis is extremely useful to provide information concerning the diagnosis and treatment plan, this is not an absolutely exact scientific method.[1] Furthermore, it should not be considered as a primary diagnostic tool; it should be considered that the treatment aims are a proportional and harmonious facial structure, without necessarily aspiring at ideal cephalometric measurements. When there are significant discrepancies between clinical evaluation and cephalometric analysis data, the clinical assessment is much more significant in preparing the treatment plan.[2]

Cephalometric radiograph analysis methods are usually based on measurements, which are compared to corresponding ones within normal range; this, however, presents inherent difficulties,[3] due to racial or ethnic differences, age and gender differences, possible differences in radiographic techniques (orientation in regard to the horizontal Frankfurt plane or in accordance to the natural head position) or differences that concern the criteria for selecting the 'normal' sample, such as occlusal features and skeletal background, at any given time. In essence, though, what is important is whether there is harmony or discrepancy between the functional structures of the craniofacial complex in the same individual rather than the agreement of cephalometric data of the individual under study when compared to the normal sample range, as this was defined by the researcher at any given time. Linear and descriptive analysis in lateral cephalometric radiographs is based on the study of jaw relationships with the cranial base and each other, the relationships of teeth with each other and their corresponding bone bases and the relationships of soft tissues in the profile view of the face. Measurements performed concern the maxilla, the mandible, the teeth and soft tissues.[4]

This composite analysis is a combination of different cephalometric analysis as follows **(Table-1, Table-2, Table-3, Table-4, Table-5)**

I. Steiners analysis[5]
II. Mcnamara anlaysis[6]
III. RakosiJarabak analysis[7]
IV. Ricketts analysis[8]
V. Tweeds analysis[9]
VI. Burstone hard tissue analysis[10]
VII. Schwarz analysis[11]

The maxillary Latitude (Table.1, Fig.1 and Fig.2)

1. The SNA Angle: this provides an indication about the anteroposterior position of the maxillary base in relation to the anterior cranial base.
2. The angle formed by the Frankfurt plane and the line defined by the nasion and point A. This is called maxillary depth and its mean value is 90°±3. This angle indicates the anteroposterior position of the maxilla in relation to the horizontal plane.
3. The distance of point A from the McNamara line (drawn through point perpendicularly to the horizontal Frankfurt plane): this indicates the position of the maxilla in relation to the anterior part of the skull and, normally, point A lies near this line.
4. The N-CF-A Angle (CF is the intersection point of the Frankfurt plane with the PTV plane). This is called maxillary height and its mean value is 56°±3. It indicates the vertical position of the maxilla in the face.
5. The horizontal position of A is measured to this perpendicular line (N-A). This measurement describes the apical base of the maxilla in relation to N and enables the clinician to determine if the anterior part of the maxilla is protrusive or retrusive.
6. Distance from PtV to the distal of maxillary molar. Assists in determining whether the malocclusion is due to position of maxillary or mandibular molar. Also useful in deciding whether extractions are necessary.
7. Anterior maxillary height is measured by dropping a perpendicular from incisal edge to nasal floor (NF).From maxillary 1st molar m-b cusp, a perpendicular line is drawn to NF. These measurements determine how far incisors and molars have erupted in relation to NF.
8. Effective length of maxilla is distance from PNS-ANS. This distance along with measurements N-ANS, N–PNS gives a quantitative description of maxilla in skull complex.

The mandibular Latitude (Table.2, Fig.1 and Fig.2)

1. The SNB Angle: This indicates the anteroposterior position of the mandible in relation to the anterior base of the skull. It should be taken into account that the values of the S-N-A and S-N-B angles are influenced by the inclination and length of the anterior cranial base S-N.
2. The facial angle: It is formed by the Frankfurt plane and the facial plane N-Pg. This angle assesses the anteroposterior position of the mandible and determines whether a skeletal Class II or III is caused by the mandible.
3. The angle formed by the mandibular plane (Go-Me) and the Frankfurt plane. This is the FMA Angle of Tweed. Its mean value is 25°±4. This angle provides an indication as to the vertical height of the mandibular ramus and the posterior facial height.
4. N-B is also measured in a plane parallel to HP from the perpendicular line dropped from N. This measurement describes the horizontal position of the apical base of the mandible in relation to N.
5. Gonial angle: The angle formed by tangents to the body of the mandible and posterior border of the ramus. It is of special interest because it not only expresses the form of mandible but also gives information on mandibular growth direction.
6. Anterior mandibular height – incisal edge to mandibular plane (MP).From mandibular 1st molar m-b cusp, a perpendicular line is drawn to MP. These measurements determine how far incisors and molars have erupted in relation to MP.
7. Ar-Go quantitates the length of mandibular ramus and Go-Pg gives length of mandibular body.

Measurements concerning dental structures (Table.1 and Table.2, Fig.3 and Fig.4)

1. The upper incisor to N-A reading in degrees indicates the relative angular relationship of the upper incisor teeth, whereas the upper central incisor to N-A reading in millimeters provides information on the relative forward or backward positioning of the incisor teeth to the N-A line.
2. The relative anteroposterior location and angulations of the lower incisor teeth is determined by relating the teeth to the N-B line. The lower incisor to N-B measurement in millimeters shows the relative forward or backward positioning of these teeth to the N-B line. The lower central incisor to N-B reading in degrees indicates the relative axial inclination of these teeth. The most labial portion of the crown of the lower incisor teeth should be located 4 mm ahead of the N-B line, whereas the axial inclination of this line should be 25 degree.
3. Incisor mandibular plane angle (IMPA): It is the angle formed by the intersection of the long axis of the lower incisor with the mandibular plane. It indicates the inclination of the lower incisor. The mean value is 90^0.
4. Frankfort mandibular incisor angle (FMIA):It is the angle formed by the intersection of the long axis of the lower incisor with the F.H. plane. The mean value is 65^0.
5. Angle between long axis of mandibular incisor and the A-Pog plane.This provides idea of mandibular incisor procumbency. Angle should be 22 ± 4^0. A-Pog line is referred to as the dental plane and is a useful reference line to measure the position of anterior teeth.Ideally, the mandibular incisor should be located 1mm ahead of A-Pog line.

Maxillomandibular relationship (Table.3, Fig.5)

The maxillomandibular relationship can be established by cephalometric norms by way of angular, linear

measurements which may be individualized or based on population norms.

The chin in position (Table.4, Fig.6)

1. Facial depth: Angle between facial plane (N-Pog) and FH.Provides indication of forward position of chin.Suggests whether a skeletal Class II or III pattern is caused by the position of mandible.
2. Convexity of middle face is measured from point A to facial plane (N-Pog).Avg. value at 9yrs is 2mm and decreases 1^0 every 5yrs. High convexity suggests Class II pattern and negative convexity suggests Class III pattern. Convexity of middle face is measured from point A to facial plane (N-Pog).Avg. value at 9yrs is 2mm and decreases 1^0 every 5yrs.High convexity suggests Class II pattern; Negative convexity suggests Class III pattern.
3. Facial axis angle: Angle formed b/w Ba-N plane and Pt-Gn.Facial axis determines the overall type of pattern of patient.The standard deviation is only 3^0.It does not change with growth.
4. N–Pg is measured in same manner. Indicates the prominence of chin.Any unusual small or large value must be compared with N–B and B–Pg, to determine if discrepancy is in alveolar process, the chin or mandible proper.
5. B-Pg describes the prominence of chin related to mandibular denture base.

Measurements concerning facial soft tissues (Table-5 and Table-6, Fig.7 and Fig.8)

A soft tissue cephalometric analysis designed for the patient who requires surgical-orthodontic care was developed to complement a previously reported dentoskeletal analysis. To make it clinically practical, the analysis has been reduced to its most relevant and significant measurements. Used along with other diagnostic aids, these soft tissue evaluations will enable the clinician to achieve good facial esthetics for his or her patients.[13,14]

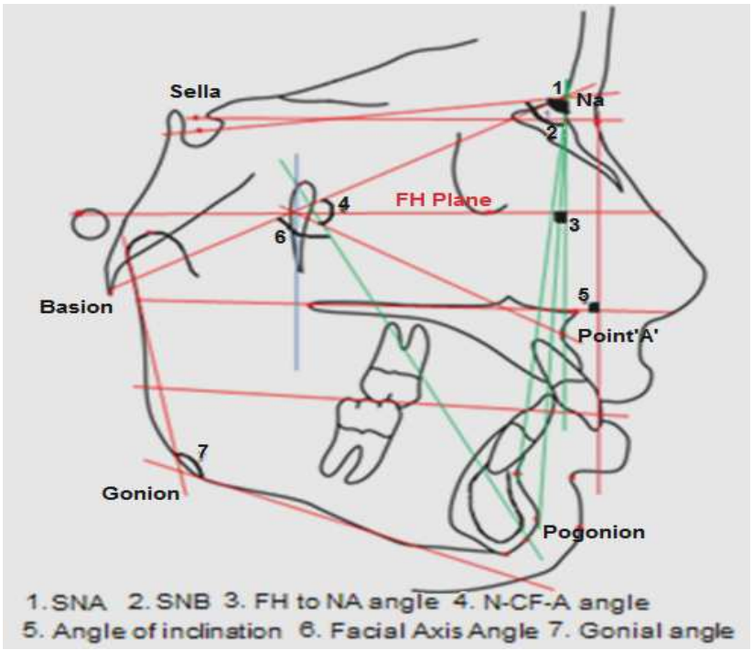

Figure.1. Angular measurements of maxilla and mandible

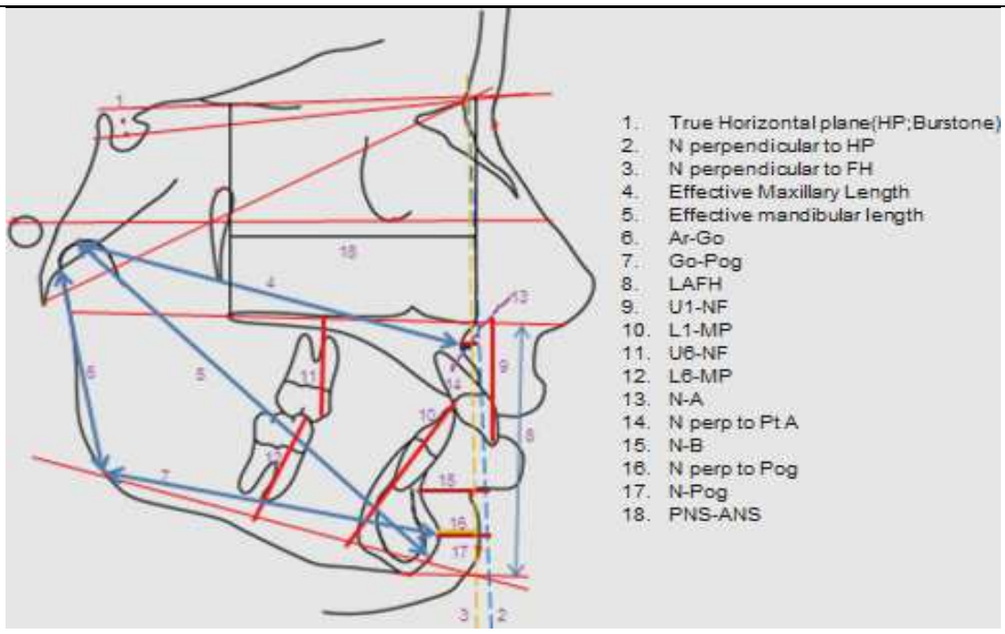

Figure.2. Linear measurements of maxilla and mandible

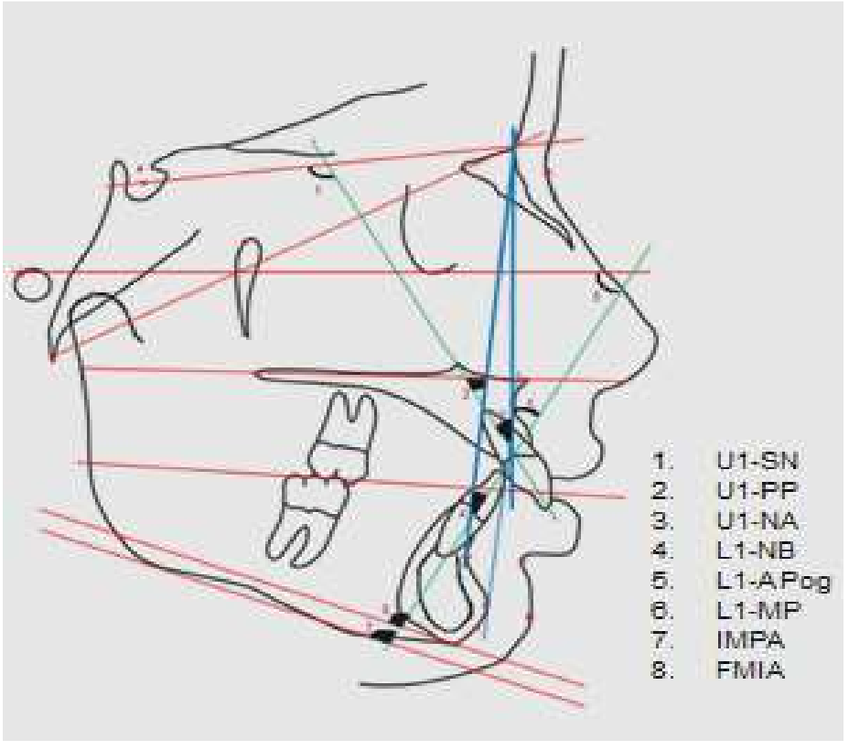

Figure.3. Angular measurements of dental parameters

Table.1. MAXILLARY MEASUREMENTS

SKELETAL			
SAGITTAL			
SNA	Steiners	82º±2	Indicates maxillary position to cranial base
FH Plane to NA Angle		90°±3	Indicates the anteroposterior position of the maxilla in relation to the horizontal plane
N-A	Burstone	M-0±3.7mm F- -2±3.7mm	Indicates maxillary position to cranial base
PNS-ANS	Burstone	M-57.7±2.5mm F-52.6±3.5mm	Determines the maxillary cranial base length
Maxillary cranial base	Schwarz	61mm	
U6 to PtV	Ricketts	Age±3mm	Determine whether malocclusion is due to position of upper or lower molar. Used in Deciding whether extractions are necessary.
N perpendicular to Pt A	McNamara	0±2mm	It represents anterior or posterior position of maxillary skeletal base
Effective maxillary length	McNamara	100±3.6mm	To know the midfacial length
VERTICAL			
N-CF-A Angle		56°±3	Indicates the vertical position of the maxilla in the face
Angle of Inclination	Rakosi	85º	Inclination of maxilla in relation to cranial base
U1 to NF	Burstone	M-30.5±2.1mm F-27.5±1.7mm	Indicates Anterior maxillary dentoalveolar height
U6 to NF	Burstone	M-26.2±2.mm F-23±1.3mm	Indicates Posterior maxillary dentoalveolar height
DENTAL			
U1 – NA	Steiners	4mm	Indicates angular relationship of the upper incisor teeth
U1 – Pt A	McNamara	4mm	To know whether upper incisor is protruded or retropositioned
U1 – NA	Steiners	22º	Indicates angular relationship of the upper incisor teeth
U1 – SN Plane	Rakosi	102 ± 2º	Inclination of incisors in relation to cranial base
U1 – Palatal plane	Rakosi	102 ± 2º	Inclination of incisors in relation to palatal plane

Table.2. MANDIBULAR MEASUREMENTS

SKELETAL			
SAGITTAL			
SNB	Steiners	80º±2	Indicates mandibular position to cranial base
Facial angle	Ricketts	86º	Suggests whether a skeletal cl - II and III pattern due to position of the mandible
N-B	Burstone	M- -5.3±6.7mm F- -6.9±4mm	Indicates maxillary position to cranial base
Go-Pog	Burstone	M-83.7±4.6mm F-74.8±5.8mm	Determines the mandibular base length
Mandibular base length	Schwarz	80mm	
N perpendicular to Pog	Mcnamara	0to -4mm	It represents anterior or posterior position of mandibular skeletal base
Effective mandibular length	Mcnamara	131 ± 4.6 mm	To know the mandibular length

Cont..,

VERTICAL			
FMA	Tweeds	25º	Indicates rotation of mandible
Gonial angle	Rakosi	128±7º	Indicates position of mandible
LAFH	Mcnamara	71.6±4.9mm	It indicates whether an excessive or deficient lower face height
L1 – MP	Burstone	M-45±2mm F-40±2mm	Indicates anterior mandibular dentoalveolar height
L6 – MP	Burstone	M-35.8±2.6mm F-32.1±1.9mm	Indicates posterior mandibular dentoalveolar height
Ar-Go	Burstone	M-52±4.2mm F-46.8±2.5mm	Indicates height of the ramus
Ascending ramus height	Schwarz	58mm	
DENTAL			
L1 – NB	Steiners	4mm	Indicates angular relationship of the lower incisor teeth
L1 – A Pog	Ricketts	1±2mm	Provides idea of lower incisor Procumbency
L1 – NB	Steiners	25º	Indicates angular relationship of the lower incisor teeth
L1 – MP	Rakosi	90±3º	Indicates angular relationship of the lower incisor teeth
L1 – A Pog	Ricketts	22±4º	Provides idea of lower incisor Procumbency
IMPA	Tweeds	90º	Indicates angular relationship of the lower incisor teeth
FMIA	Tweeds	65 º	Indicates angular relationship of the lower incisor teeth in relation to FH plane

Table.3. MAXILLARY AND MANDIBULAR RELATIONSHIP

MAXILLARY AND MANDIBULAR RELATIONSHIP			
SAGITTAL			
ANB	Steiners	2º±2	Indicates relative position of maxilla and mandible
Beta angle[12]	Chong YoBaik	27 º - 35º	Suggests whether it is skeletal cl - II and III pattern
N-A-Pog	Burstone	M-3.9º±6.4º F-2.6º±5.1º	Indicates relative position of maxilla and mandible
A-B	Wits appraisal	M-1.1±2mm F-0.4±2.5mm	Indicates relation between maxilla and mandible in relation to occlusal plane
Maxillofacial difference	Mcnamara	26.8±4.1mm	It is used to know the jaw is too large or small
Convexity at Pt A	Ricketts	2±2mm	Suggests whether it is skeletal cl - II and III pattern
VERTICAL			
Basal plane angle	Rakosi	27º	Indicates relation between maxilla and mandible
Jarabak ratio	Rakosi	62-65%	Determines the vertical relationship of the jaws

Table.4. MEASUREMENTS FOR CHIN POSITION

CHIN ANALYSIS			
SND	Steiners	76º	Indicates position of chin in relation to cranial base
Facial Depth	Ricketts	87 ± 3º	Indicates position of chin in relation to forehead
Facial Axis angle	Ricketts	90 ± 3.5º	Determines three dimensional position of chin
N-Pog	Burstone	M - 4.3±8.5 F - 6.5±5.1	Indicates position of chin in relation to true horizontal plane
B-Pog	Burstone	M 8.9±1.7 F 7.2±1.9	Determines the hard tissue chin thickness

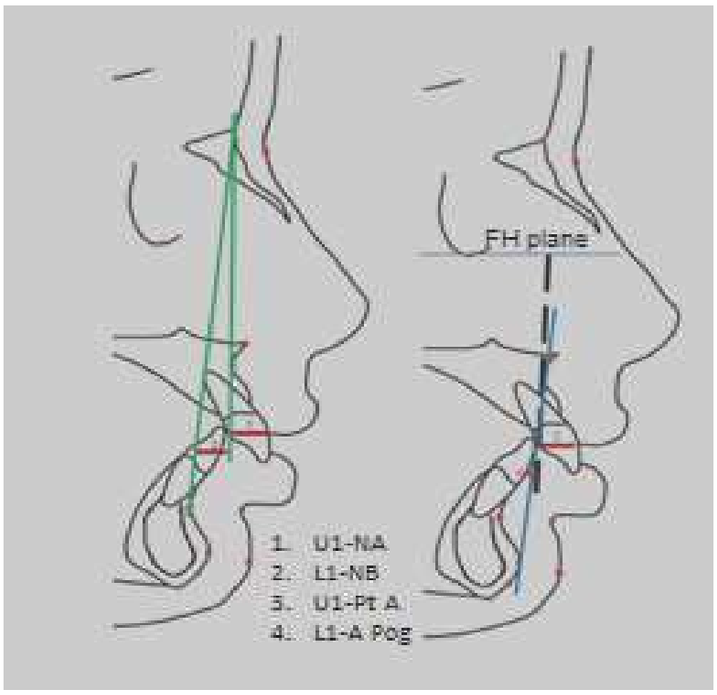

Figure.4. Linear measurements of dental parameters

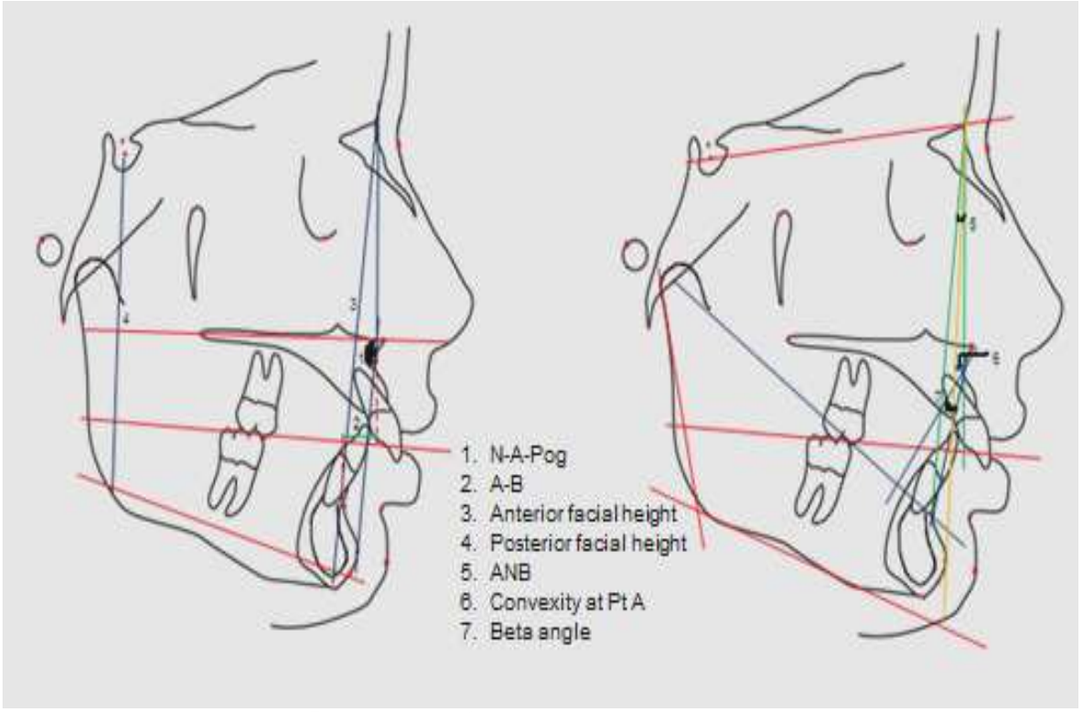

Figure.5. Measurements considering maxilla and mandible

Table.5. BURSTONE SOFT TISSUE ANALYSIS

REFERENCE POINTS	NORMAL RANGE	INFERENCE
Angle of Convexity	12^0	Determines the facial profile
Ratio of the middle third to the lower third of facial soft tissues	1:1	Determines the proportion of face
Upper lip height	22±2mm	Determines the vertical height of the lower two thirds of the lower third of the face.
Upper lip protrusion	3mm	Indicates the position of upper lip
lower lip protrusion	2mm	Indicates position of lower lip
Nasolabial angle	102^0	Determines soft tissue profile of the face
Mentolabial angle	4mm	Indicates the position of chin
Mentocervical angle	100^0	
Throat length	40±5mm	Useful to ensure differential diagnosis between anteroposterior mandibular excess and maxillary hypoplasia.
Vertical chin lip ratio	1:2	Determines the proportion difference between lip and chin
Interlabial gap	2mm	Determines the competency of lips
Maxillary incisor exposure	2mm	Determines the length of upper lip

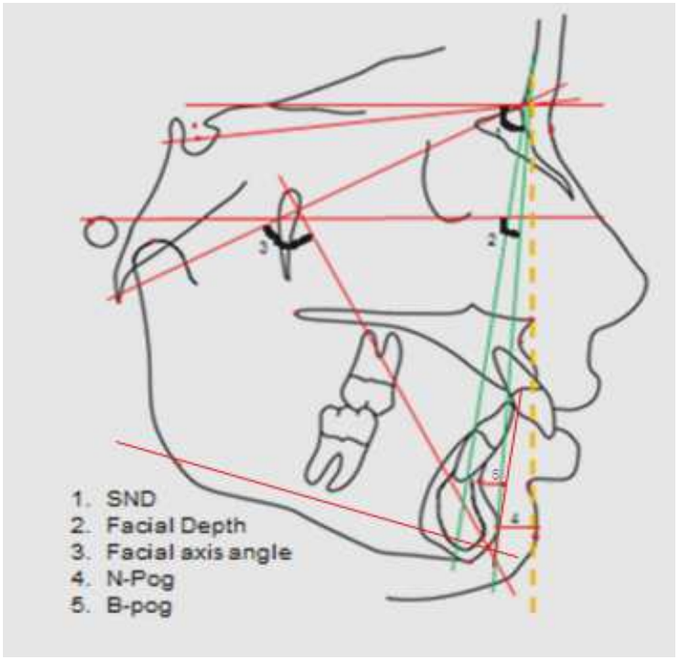

Figure.6.Measurements considering chin position

Table.6. HOLDAWAY SOFT TISSUE ANALYSIS

REFERENCE POINTS	NORMAL RANGE	INFERENCE
Soft tissue facial angle	$91^0 \pm 7^0$	This value indicates a recessive lower jaw.
Skeletal convexity at pt A	-2 to +2mm	This value indicates that dental harmony is needed to produce facial harmony
Upper lip curvature	2.5mm	Indicates position of upper lip
H angle	$7 – 15^0$	This value indicates increased soft tissue convexity.
Nose prominence	14 to 24mm	This value indicates that nose is considerably small.
Soft tissue Sub nasale to H line.	5 ± 7 mm	This value indicates greater skeletal convexity.
upper sulcus depth	1 to 4 mm	The curl of the upper lip form is normal
upper lip thickness	15 mm	This value indicates it is with in normal range.
Upper lip Strain	13 to 14mm	This value indicates that there is no lip strain
Lower lip to H line	-1 to + 2mm	This value indicates that that lower lip is ahead of the H line.
Lower sulcus depth	5 mm	This value indicates that certain axial inclination of lower teeth is required
Soft tissue chin thickness	10 to 12mm	This value is within normal range.

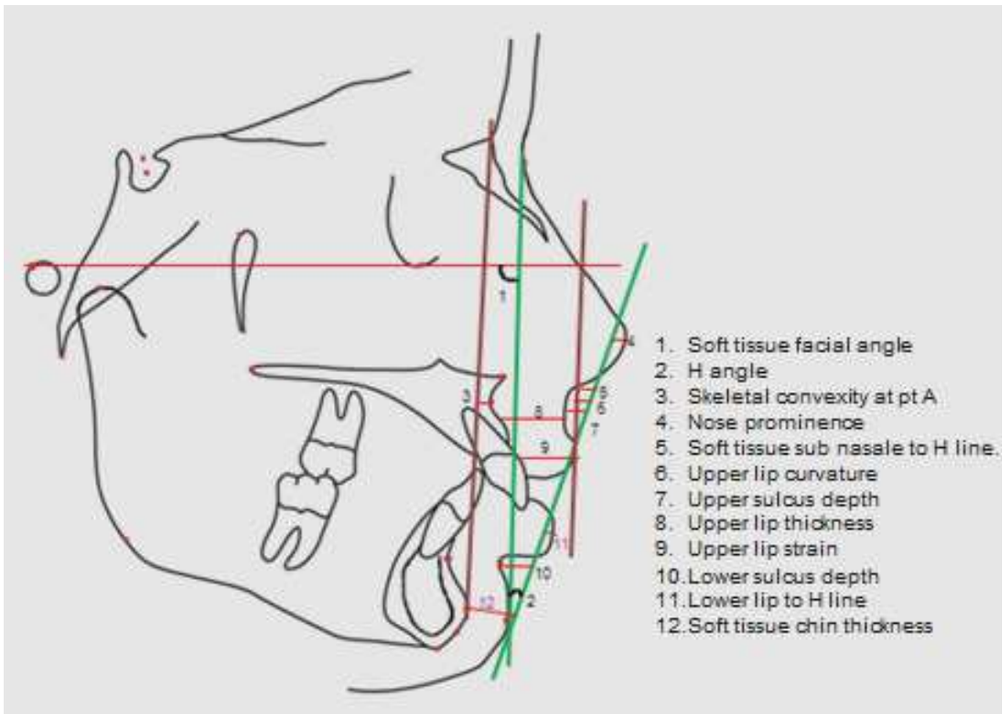

Figure.7.Holdaway soft tissue analysis

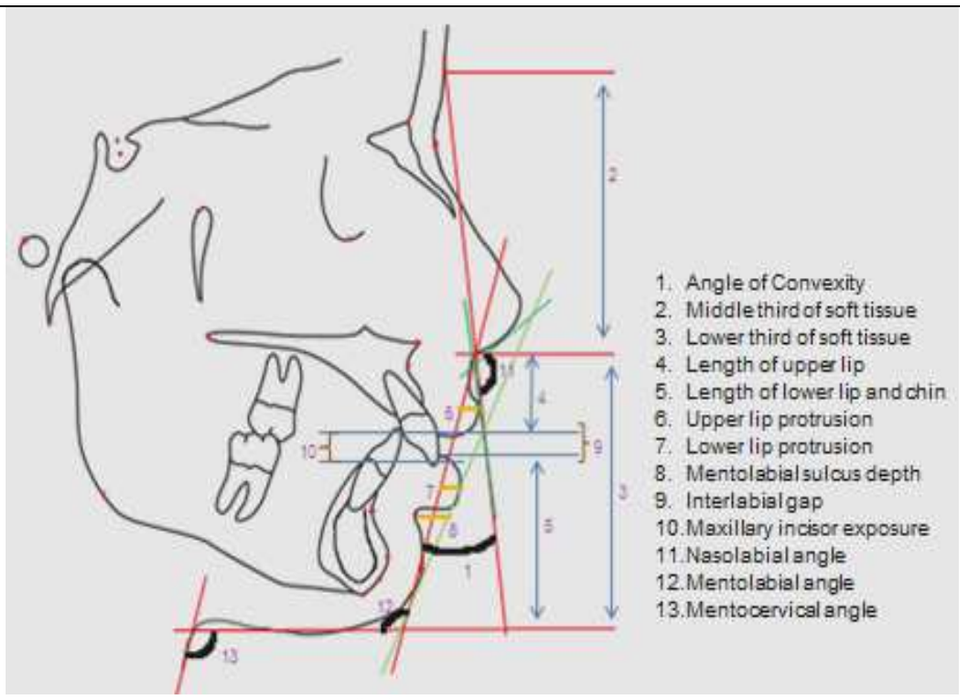

Figure.8. Burstone soft tissue analysis

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