

A Comprehensive Evaluation Of Hard And Soft Tissue Parameters In Orthognathic Surgery: A Review

Snehal Bhalerao¹ Aameer Parkar² Chetan Patil³ Pradeep Kawale⁴ Pradeep Kumar⁵ Sonal
Dhumal⁶

¹Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India,

²Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India.

³Professor and Head, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India.

⁴Reader, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India,

⁵Reader, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India.

⁶Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India.

ABSTRACT

Background: Dentists and dental specialists' professional background and experience are focused almost exclusively on dental occlusion. All too often in a zeal to improve dental occlusion, clinicians plan a method of treatment based on inadequate or improper diagnostic criteria. When these treatment plans include surgical procedures, dramatic changes in facial soft tissue contour can be produced.

Keywords: Hard tissue, Soft tissue, Orthognathic Surgery, dentistry.

INTRODUCTION

In modern orthognathic surgery, the **Orthodontist and Oral and maxillofacial Surgeon** need to work in complete symbiosis to achieve a facial balance in harmony with the underlying dental and skeletal structures. The orthodontist is in a unique position to govern the success of an orthognathic surgical case by precisely positioning the teeth (decompensation) prior to surgery. Incorrect positioning of the incisors in either arch can have a profound influence on the extent of the overjet (reverse or positive), and thus on the ability of the surgeon to produce the desired profile changes. It is, therefore, the responsibility of the orthodontist to set clear goals before the start of treatment and to communicate these to the surgical colleague

Basic Considerations

Dental Compensations

Alterations in normal axial inclinations of the incisors may overcome skeletal base disproportions

and attempt to maintain functional occlusion. These alterations of vertical length and axial inclinations in response to deviate skeletal growth are termed *dental compensations*. Jaw mal relations result from disproportional facial growth. As these disproportions progressively manifest, the teeth attempt to mask the disproportional change and functional liability by compensating their positions through tooth movement. In other instances, the teeth are forced to migrate by perverted muscular actions resulting from the jaw mal relations. Orthodontic treatment planned without surgery generally will build in more dental compensations for skeletal variation. Orthodontic treatment planned in conjunction with surgery will remove dental compensations. Thus, orthodontic tooth movement planned without surgical treatment is in the opposite direction of the tooth movement when surgery is planned. Therefore, it is desirable that the total treatment plan be determined before therapy is begun.

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*Correspondence Dr. Snehal Bhalerao.

Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College and Hospital, Khed, Maharashtra, India.

Email: Snehalbhalerao1@gmail.Com

Facial Soft Tissue Analysis

Facial soft tissue is the ultimate compensating factor in facial contour morphology. Since the facial soft tissue is the ultimate compensator, a proper diagnosis and treatment plan must include a meaningful analysis of facial soft tissue contours. Analysis of proportional facial contours can identify and localize areas of disproportion and compensation. Cause and effect relationships between alterations of dental, skeletal and soft tissue changes must be understood.

Mandibular prognathic patients who have Class III dentitions, short heavy throats, and larger than normal lip-chin-throat angles should not usually have mandibular setbacks. Such procedures on these patients all too often result in profiles that are retrognathic. As a general rule it is unwise to change a profile from one extreme contour to another, for example, from a prognathic mandible to a retrognathic mandible (i.e., -2° facial contour angle to -18°). It is important to plan our treatment so that the resulting facial contour angle is between -3 and -11° . This allows a modification of the facial contour without drastically changing the facial type.

Cutcliffe suggested soft tissue vertical proportions. With these proportions, it is possible to assess the quality of vertical soft tissue harmony. Deviations of direction and amount can be quickly localised, and proper orthodontic tooth movement and skeletal surgery can be designed to focus on the localised deviations. By placing a cephalometric tracing over a diagnostic contour protractor registered at the subnasale and tangent to the glabella, a quick evaluation of the profile soft tissue position and proportionality can be performed. Dental compensations and skeletal deviations can be equated with soft tissue contours.

The design of the surgical procedure will be dictated by the soft tissue evaluation

An individualised treatment can be planned for each unique malocclusion or facial deformity; it can be designed to locate a *target zone for the intended correction*. The proper anteroposterior relationship and vertical balance for the patient locate the target zone of the pogonion-menton area. A separate template is made of the original tracing outlining the mandible, molar, incisor and soft tissue between

the pogonion and menton and positioned on the tracing so that the soft tissue pogonion is near the -11° facial contour angle; menton is at the proper vertical height at "Y"; and the molars are acting as posterior occlusal stops "c" and "d".

The incisor relationships are evaluated, and decisions are made as to how the incisors can be adjusted to their new positional requirements. Extractions, expansion, arch length adjustment and anchorage limits are alternatives used to reposition dental units. The ultimate question will be whether surgery is necessary, or whether an orthodontic solution alone provides a reasonable prognosis. Locating remaining soft tissue landmarks so that an estimated profile can be drawn. The predicted profile change is superimposed on the original tracing.

Analysis of Mandibular Rotations in Surgeries

During mandibular setback operations, the mandible may rotate clockwise (posterior), counterclockwise (anterior), or translate depending upon the original incisal overbite. As a general rule, anterior open-bite situations create counterclockwise rotational setbacks, while overbite situations create the opposite. The concern with rotational setbacks is that pogonion does not move in a 1:1 relationship with mandibular incisal movement. In clockwise rotations, pogonion will decrease in prominence antero posteriorly much more rapidly than the incisors. Therefore, the facial contour angle can rapidly become retrognathic

Conversely, in severe counterclockwise mandibular setbacks it is not unusual that pogonion becomes more prominent. Consequently, the facial contour angle becomes flatter even though the mandible is set back. Care must be taken during treatment planning to consistently locate posterior molar occlusal stop areas. Molar and incisor outlines provide posterior and anterior stops which predict how the mandible will rotate during surgical setback which ultimately provides a satisfactory or unsatisfactory facial profile.

After the dental compensations have been adjusted orthodontically, pre surgical records should be retaken to verify the original treatment plan. Actual incisal and molar positions rather than projected positions will provide a more definitive estimate of

surgical requirements and profile change. If updated soft tissue changes appear unfavorable, the treatment plan can be modified to correct deficiencies before **committing** to surgery.

Cephalometric Analysis

McNamara's Analysis

Presented by Dr. James A Mc. Namara as an original article in the December 1984. This method of analysis is derived in part from the principles of the Ricketts' and Harvold analyses

Basis

The Mc Namara analysis is useful in diagnosis and treatment planning of the individual patient when values derived from the tracing of the patients' head film are compared to established norms; the norms from 3 groups have been derived:

- The Bolton study
- The Ann Arbor sample (200 adults)
- The Burlington sample Composite norms.

Parameters

Relating maxilla to cranial base

Relating maxilla to mandible

Relating mandible to cranial base

The dentition

Airway analysis

I.Relating the maxilla to cranial base: Soft Tissue Evaluation

The nasolabial angle is formed by the intersection of a line tangent to the base of the nose with a line tangent to the upper lip.

Norms

110° (Scheidemann et al)

102°± 8° (Ann Arbor sample)

Acute naso Labial angle=Dentoalveolar Protrusion /orientation of the base of the nose.

Cant of Upper Lip : The cant of the upper lip should be evaluated relative to the vertical orientation of the face.

The upper lip to nasion perpendicular angle should be:

14°± 8° in females (Ann Arbor sample)

8°± 8° in males (adult)

Hard Tissue Evaluation

The antero-posterior position of the maxilla is determined by Constructing the Nasion perpendicular. The Linear distance from point A to Nasion Perpendicular is Measured

Ann Arbor Norm=0.4mm(male)

Comp Norm=0mm(Mixed Dentition)

1mm(adult)

Data derived from the Bolton standards indicate that the SNA angle increases minimally with age (approximately 1° from ages 6 to 18). Since a 1° change at point A is equivalent to a 1 mm linear change in the position of point A relative to nasion, one can extrapolate the position of point A relative to the nasion perpendicular during the mixed dentition

Thus, the composite norm for the relationship of point A to the nasion perpendicular is *0 mm in the mixed-dentition person and 1 mm in the adult female and the adult male*.

Drawbacks

1) It is affected by the position of the nation, which is itself affected by cranial base length.

2) There is displacement of point A labially when the roots are anteriorly tipped.

II) Relating the mandible to the maxilla (midface):

Effective midfacial length is determined by measuring a line from condylion to point A. An Effective mandibular length is derived by

constructing a line from condyion to anatomic gnathion'

A given effective midfacial length corresponds to an effective mandibular length within a given range. "these are not directly related to patient's age or sex"

A geometric relationship exists between the effective length of the midface and that of the mandible. Any given effective midfacial length corresponds to a given effective mandibular length. If the effective midfacial length is subtracted from the mandibular length, the maxillomandibular differential can be determined. Ideally, this differential is 20 mm for small-sized persons, 25 - 27mm for medium-sized persons and 30-33 mm for large-sized persons.

Vertical Dimension

The clinical appearance of the relation between upper and lower jaws is affected greatly by lower anterior facial height (measured from ANS to menton). This linear measurement increases with age and is correlated to the effective length of the midface.

E.g.: In Mixed dentition Analysis

Mid face Length= 85mm

Lower Anterior Facial Height= 60-62mm

In Medium sized individuals

Mid face Length= 94

Lower Anterior Facial Height= 65-67mm

In Large sized individuals

Mid face Length= 100

Lower Anterior Facial Height= 70-73mm

In growing persons, an increased LAFH camouflages a similar increase in mandibular length, resulting in the appearance that the chin is in the same position A-P, with respect to cranial base structures.

This analysis also includes two other measurements:

1)Mandibular plane angle:

2)Facial axis angle of Ricketts:

Mandibular Plane Angle

Angle between F-H plane and Go-Me

Normal Value:22°+/- 4°

Adult south indian-18.9

Adult north indian-19

(Elbe Peter, Valiathan Ashima et al JPFA 2000)

Higher Value: Excessive Lower Facial height

Lower Value: Deficiency in Lower Facial Height

Facial Angle Axis of Rickets

a) Posterosuperior aspect of pterygomaxillary fissure to gnathion

b) Line joining Basion to Nasion

Balanced Face =90°

Excessive vertical development , =Less than 90°(negative value)

Deficient vertical development, =Higher than 90°(positive value)

Thomas and Valiathan (June 1993) reported normal directed growth of chin

90.65+/- 3.33

89.64 +/- 5.06 (Adult South Indians)

90.07 +/- 3.16 (Adult North Indians)

III. Relating the mandible to the cranial base:

The relationship of the mandible to the cranial base is determined by measuring the distance of

the pogonion to the Nasion perpendicular.

According to the composite norms:

In a mixed dentition (balanced face) pog lies 8mm to 6mm (i.e., posterior) with respect to Nasion

In adult male the chin position is usually -2mm to +2,, relative to Nasion perpendicular.

Dentition Analysis:

A.Relating Upper Incisor To maxilla A vertical line is drawn through point A parallel to nasion $\perp$

The distance from point A to the facial surface of Upper incisor is measured $\rightarrow$ A-P position of Upper incisor

Composite Norms= 4-6mm(Adults

Vertical Position of Upper Incisor

Clinically, and typically, the incisal edge of upper incisor lies 2-3 mm below upper lip at rest. This is subject to adjustment depending on functional state of lip musculature and axial inclination of the tooth prior to treatment. Relating the lower incisor to the mandible

Determined by using a traditional version of the Ricketts measurement of the facial surface of the lower incisor to the A-Pog line.

Bolton study Norms: 1.5 mm anterior to the A Pog. Line.

Ann Arbor Norms :2.3-2.7mm anterior to the A Pog. Line.

INDIAN NORMS (Elbe Peter, Valiathan Ashima et al JPFA 2000)

ADULT SOUTH INDIAN-2.87mm

ADULT NORTH INDIAN -2.85mm

Airway analysis

Upper pharynx

The upper pharyngeal width is measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall.

This is because the area immediately adjacent to the posterior opening of the nose is critical in determining upper respiratory patency

Apparent airway obstruction, as indicated by an opening of 2mm or less in the upper pharyngeal measurement is only an indicator of possible airway impairment.

For a more accurate diagnosis, an ENT examination is required.

Lower pharynx

Lower pharyngeal width is measured from the intersection of the posterior border of the tongue and inferior border of the mandible to the closest point on the posterior pharyngeal wall.

Ann Arbor sample =10-12mm (average value) does not change appreciably with age

Smaller than average values are not significant,

Greater than average value,15mm suggests anterior positioning of the tongue, either as a result of habitual posture, or due to enlargement of tonsils.

Certain conditions associated with greater than average Lower pharyngeal width are:

- Mandibular prognathism
- Dento-alveolar anterior crossbite
- Bialveolar protrusion of teeth

CEPHALOMETRICS FOR ORTHOGNATHIC SURGERY (COGS) *Burstone CJ, James RJ, Legan H, Murphy GA, Norton LAJ Oral Surg 1978*

Cranial Base

Baseline for comparison of most data in this analysis is HORIZONTAL REFERENCE PLANE.(HP)

Constructed plane , 7°from SN line.

Most measurements are made either parallel or perpendicular to horizontal plane.

Length of cranial base – Parallel to HP from Ar – N.

Ar – N is a relatively stable anatomical plane; however it can be changed by cranial surgery that affects N, such as Lefort II & III osteotomies. Or with auto correctional rotations of the mandible where Ar moves closer to N.

Ar-Ptm : Angle of Facial Convexity

Gives an indication of overall facial convexity, but not a specific diagnosis of which is at fault – maxilla or mandible.

Positive angle – convex face.

Negative angle – concave face.

Clockwise angle is positive.

Counterclockwise is negative.

It describes the apical base of maxilla/mandible in relation to N.

The surgeon has a quantitative assessment of the A-P position of jaws and degree of horizontal dysplasia, and is important in the planning of treatment of anterior jaw horizontal advancement/reduction or total advancement/reduction

N – Pg

The measurements of horizontal skeletal profile represent facial convexity, horizontal relation of apical base A & B points, and chin as related to N.

After all the measurements are considered the surgeon has a quantitative skeletal cephalometric facial description of horizontal anterior facial discrepancy.

VERTICAL SKELETAL MEASUREMENTS.

A vertical discrepancy may reflect an anterior, posterior or complex dysplasia of the face. therefore these measurements are divided into –

- Anterior &
- Posterior components

Anterior Component

Posterior component – a) Posterior maxillary height is length of a perpendicular line from HP intersecting PNS.

b) Divergence of mandible posteriorly is shown by MP-HP angle. MP is formed by Go-Gn.

It relates to posterior facial divergence with respect to anterior facial height.

Both these measurements define the vertical dysplasia of the posterior components.

Vertical skeletal measurements of anterior & posterior components of face will help in diagnosis

of anterior , posterior , or total vertical maxillary hyperplasia or hypoplasia, and clockwise or counterclockwise rotations of the maxilla & mandible.

VERTICAL DENTAL DYSPLASIA

ANTERIOR

POSTERIOR

All these values should be related to ANS-Gn & MP-HP to establish whether the origin of maxillary & mandibular discrepancies is skeletal, dental or both.

Effective Maxillary Length

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

MANDIBLE

- 1) Ar-Go quantitates the length of mandibular ramus.
- 2) Go-Pg gives length of mandibular body.
- 3) Ar-Go-Gn angle gives relation between ramal plane & mandibular plane.
- 4) B-Pg describes the prominence of chin related to mandibular denture base.

These measurements are helpful in diagnosis of variations in ramus height, that effect open bite/deep bite problems, increased /diminished mandibular body length, acute or obtuse Go angle that also contribute to skeletal open/closed bite. Assessment of chin prominence.

Dental Measurements

Occlusal Plane

Occlusal plane (OP) is drawn from buccal groove of both permanent 1st molars through a point 1mm apical of incisal edge of central incisors in respective arch.

OP angle is angle between OP and HP.

If the teeth overlap anteriorly to produce an overbite the OP can be drawn as a single line

INCREASED – Skeletal open bite, lip incompetence, increased facial height, retrognathia or increased MP angle.

DECREASED – Deep bite, decreased facial height, lip redundancy.

AB-OP

Angulation of maxillary incisor to NF and mandibular incisor to MP is measured.

They determine the procumbency or recumbency of incisor & are vital in assessing the long term stability of the dentition

A consultation with an orthodontist will be helpful in trying to establish the most stable relationship of the angulation of the teeth to the denture base and to the lips and tongue.

SOFT TISSUE CEPHALOMETRIC

Means & standard deviation derived from 40 orthodontically untreated white adults (20 men, 20 women). Class I occlusion, Vertical facial proportions within normal limits.

Facial convexity

Given by angle G – Sn – Pg'.

Smaller value – Class III profile.

Clockwise angle – Positive.

Counterclockwise angle – Negative

Maxilla & mandibular are related to a line dropped from glabella perpendicular to horizontal reference plane.

Maxillary – Distance to subnasale from this line.

Gives amount of maxillary excess or deficiency in A-P dimension.

Anterior to line – Positive, Posterior - negative

This & other related A-P measurements are important in planning treatment for anterior maxillary advancement or reduction and for total

alveolar or lefort I maxillary horizontal advancement or reduction.

Mandible

Distance from perpendicular line dropped from glabella to Pg'.

Gives an indication of mandibular prognathism or retrognathism

This measurement must be evaluated in conjunction with others to distinguish between

microgenia—small hard tissue chin,

micrognathia—small mandible retrognathia—average sized mandible positioned posteriorly

Thin soft tissue chin or combination of these

Vertical

Ratio of distances G – Sn & Sn – Me' should be approx. 1.

Less than one indicates larger lower third of the face

Lip Position (Nasolabial Angle)

Nasolabial angle – between Cm-Sn-Ls.

Important measurement in A-P maxillary dysplasias.

Acute angle allow us to surgically retract maxilla or maxillary incisors or both.

Obtuse angle – maxillary advancement or proclination of incisors.

AP Lip Position

Labiomental Sulcus

From depth of sulcus perpendicular to Li-Pg' line.

Sulcus of about 4mm provides pleasing lower lip to chin contour.

Uprighting lower incisors, intruding maxillary incisors, chelioplasty can help in reducing a deep sulcus.

Upper Lip – Maxillary Incisor

Distance of upper lip to maxillary incisor (Stm – 1) is a key factor in determining vertical position of maxilla.

Normal – 2mm of incisor display.

Patients with vertical maxillary excess tend to show a large amount of upper incisor with lips in repose.

Clinical Significance

Vertical maxillary deficiency – No incisor display with lips relaxed, edentulous look.

Orthodontically extruding maxillary teeth or surgically positioning the maxilla inferiorly – preferable treatment in patients with short face.

INTERLABIAL GAP – Approx. 3mm .

Patients with maxillary excess have large interlabial gaps & lip incompetency.

Quadrilateral Analysis

Di Paolo 1962

It attempts to identify skeletal deviations, in size and position, in both the horizontal and the vertical dimensions, regardless of dentoalveolar relationships. It provides an individualized skeletal assessment of each patient. Proportional analysis which is based on theorems in Euclidean geometry. Sample – 245 subjects, mean age-12.6 yrs.

Maxillary Bony Length

Mandibular Bony length

POINT J

Anterior Lower Facial Height

Posterior Lower Facial Height

The quadrilateral analysis indicates that in a balanced facial pattern a 1:1 ratio exists between the maxillary bony base length (Max.Lth.) and the mandibular bony base length (Mand.Lth.);

Average of the anterior lower facial height (ALFH) and posterior lower facial height (PLFH) equals these bony base lengths.

Max.Lth. = Mand.Lth. = ALFH + PLFH

Dental Analysis

Maxillary Incisor Position

A perpendicular from this line to the most anterior point on the maxillary incisor should result in a measurement of 5 mm $\pm$ 1 mm.

Pogonion Line

The most anterior point of the mandibular incisor should be $\pm$ 2 mm to this line.

This measurement will indicate if the chin is excessive or deficient in size

Sagittal Ratio

Important in assessing the relative anteroposterior position of the maxillary and mandibular bony bases.

Skeletal malformations of the jaws may be either in the bony bases or located posteriorly. Therefore, pinpointing the area of the deformity will have a significant impact on whether or not certain surgical procedures are indicated.

For example, if we are to perform a surgical correction of a mandibular prognathism, it would be necessary to determine whether we should reduce the bony base lengths (body osteotomy or sagittal split setback) or whether we should perform mandibular surgery posterior to the bony base area (vertical osteotomy, etc.)

The lines used to measure the bony base lengths are extended posteriorly to point x, which is the sagittal angle

When the anterior and posterior lower face heights are parallel and the maxillary and mandibular bony bases are equal, a proportional relation exists with sides A, B, C, and D of the similar isosceles triangles.

The ratio of A to B and C to D is called the sagittal ratio.

Angle of facial convexity

This angle is formed by the intersection of anterior lower facial height with anterior upper facial height

and relates the quadrilateral to the upper face.(165 - 178°)

Facial Types

TYPE 1

This face has a normodivergent pattern showing a favorable vertical growth .

In the majority of Type 1 cases, the maxillary and mandibular basal arch lengths are equal and the average vertical height is equal to the arch length. This balance indicates a harmonious skeletal development of the lower face

In the majority of Type 1 cases, the maxillary and mandibular basal arch lengths are equal and the average vertical height is equal to the arch length.

This balance indicates a harmonious skeletal development of the lower face

Malocclusions in this group are dentoalveolar in origin. Tooth size— arch length discrepancies or anterior or posterior position of the teeth on their respective denture bases account for the majority of problems

TYPE 2

This face is hypodivergent, predominantly horizontal growth pattern.

There is a reduction in lower face height with an undesirable growth pattern, resulting in a skeletal deep-bite

In these patients the average vertical height is deficient when compared to the denture base lengths.

TYPE 3

This face is hyperdivergent, predominantly vertical growth pattern . There is an increase in lower face height with an undesirable growth pattern, resulting in a skeletal open-bite.

In these patients the average vertical height is excessive when compared to the denture base lengths.

TOMAC: AN ORTHOGNATHIC TREATMENT PLANNING SYSTEM SOFT-TISSUE ANALYSIS- TONY G. McCOLLUM,

TOMAC an acronym for the author's name is a surgical orthodontic treatment planning and prediction system designed to identify the best possible soft tissue profile by testing the effects of various orthodontic and surgical options.

TOMAC VTO

TOMAC is a unique surgical-orthodontic treatment planning system. The essential underlying principle is that the soft-tissue profile is changed first, setting a goal toward which hard-tissue changes are adapted.

The TOMAC VTO is constructed in three stages:

1. TEST VTO
2. PRE SURGICAL VTO
3. SURGICAL VTO

Test VTO

This is where the various orthodontic and surgical options are tested and the optimum combination is visualized. In the anteroposterior plane, the facial contour angle (FCA) is changed to the chosen ideal. The upper and lower jaws, or both, are traced in their new positions according to the soft-tissue reactions to surgical movements, and the teeth are then decompensated accordingly.

Pre Surgical VTO

This is constructed from the information in the test VTO.

Any necessary incisor decompensations, molar adjustments, and soft-tissue changes become the orthodontic objectives prior to the surgical procedure.

Surgical VTO

The surgical VTO is constructed over the presurgical VTO, with the surgical cuts diagramed on the tracings of the jaws.

The simulated surgical movements are governed by the decompensated positions of the incisors. The

soft-tissue profile is then drawn according to the expected soft-tissue/hard-tissue ratios of movement

VIDEO IMAGING

In the VTO of an orthognathic surgery case, the clinician classically has used acetate templates of the teeth and jaws to predict orthodontic and surgical movements to attain their esthetic and functional goals, and the final profile is determined by the reaction of the soft tissue to the hard tissue movements

Cephalometric digitizing programs are useful in automating these predictions

Video imaging technology allows the orthodontist to gather frontal and profile images and modify them to project overall esthetic treatment goals

The advantage that video cephalometric planning often offers is that

(1) it allows facial visualization for better comprehension of the facial response to the dental and/or soft tissue manipulation involved in a particular treatment plan;

2) it allows quantification of the planned dental and/or osseous movements to reduce the guesswork as to the facial response to our orthodontic treatment plan; and

(3) it allows the clinician to test various treatment plans before deciding on the final plan. This is the essence of the video imaging concept because it allows us, at least in adult or surgical cases, to determine beforehand the facial result of proposed treatment.

Kazandijan AJO 1999

For patients undergoing Class III mandibular setback, video imaging proved to be accurate enough for use in communication and patient education.

2. Video imaging proved to be marginally acceptable as a tool for diagnosis and treatment planning in Class III surgical cases due to the fact that 30% of the sample showed errors greater than 2 mm in their predictions

In the future, computerized tracing and video imaging techniques in three dimensions may be faster and more efficient than conventional tracing methods.

With soft-tissue responses to hard-tissue movements better understood than in the past, these and other influential factors could be incorporated into computerized technology, to provide extremely accurate treatment planning information.

CONCLUSION

Surgical analysis offers the opportunity to identify treatment goals in the vertical and anteroposterior planes, allowing the clinician to be more confident in making the difficult decision of whether a case can be treated by orthodontics alone or requires orthognathic surgery.

Our ability to predict the outcome of any orthognathic procedure relies on the surgeon's ability to accurately reproduce the desired skeletal movements and on our understanding of the soft tissue changes associated with those movements.

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