The Art and Science of Orthodontic Diagnosis and Treatment Planning

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Introduction

Artists paint a canvas from what they know, what they feel and what they actually see. To a remarkable degree, many orthodontists approach diagnosis in the same way. While it may be permissible for artists to create paintings from what they know or feel, orthodontists would do well to evaluate objectively only what they see. If there is any secret to accurate diagnosis and treatment planning, it is not to let previously acquired knowledge or feelings about a patient interfere with what is seen.

Unfortunately, by training and by patient expectation, dentists are primarily therapists and so they often launch into action before rendering a complete diagnosis. For many patients, the etiologies and remedies of problems are obvious and the ensuing acceleration of treatment causes few problems. But whenever the diagnosis is obscure or difficult, patients will suffer from our haste and clinicians are often baffled about their ineffective regimens. In my own personal experience, the most grievous mistakes I make are those from misdiagnosis. Orthodontists can easily overcome errors of mechanics but have much more trouble correcting a wrong diagnosis. A sound diagnosis remains the foundation of all successful therapy and the primary responsibility of conscientious clinicians.

In this initial chapter, I want to acquaint the reader with some techniques I use for collecting, assembling and using patient data to reach a diagnosis and treatment plan. Some of the methods I have included are universally applied and well understood, but other methods I consider important and included under Systems Analyses seem to have little appeal to most orthodontists. I would like to increase the profession's understanding and appreciation for these procedures by making them convenient and practical. I bring all the collected data together to form a Tridimensional Diagnosis that positions the teeth and jaws vertically and horizontally through the Visualized Treatment Objective and transversely through the occlusogram.

Section I: Patient Data Collection

Chief Complaint

The first step in forming an accurate diagnosis in any of the healing arts begins with a collection of information from patients regarding their concerns. The chief complaint of the patient should be recorded in the patient's own words to prevent confusing the clinician's perception of the problem with the description offered by the patient (Figure 1:1).

Figure 1: 1: Patient pointing out her chief complaint.

The importance of this point cannot be overemphasized, since any therapy that fails to address the patients' main concern will be considered a failure-no matter how satisfying it may be to the clinician. So the orthodontist's first task is to listen to the patient and make certain the chief complaint is understood.

General Health Questionnaire

Certainly, a general health questionnaire will help the orthodontist discover systemic defects or medications that might affect orthodontic therapy. For instance, daily medication with nonsteroidal anti-inflammatory agents (such as ibuprofin or aspirin) inhibits ordinary bone metabolism.[1,2] Constant use of such drugs makes routine rotational corrections or space closures almost impossible to achieve. There are several systemic medications or conditions that affect orthodontic treatment, and doctors need to discover them before treatment begins (Figure 1:2).

An assessment of the patient's temperament also alerts us to the difficulty or ease orthodontists might have with enlisting the patient's cooperation in treatment.[3] A patient's personality will not change the diagnosis, but studies[4] show that this information should be used in the selection of treatment mechanics and appliances (Figure 1:3).

Medical History

Please check any of these the patient has had.

Problem	**Solution**
o Atherolsclerosis	
o Rheumatoid arthritis	
o Swollen, stiff or painful joints	
o Heart murmur or heart problem	
o Fainting spells	
o Easily fatigued	
o Cold hands	
o Bruises easily	
o Slowly healing sores	
o Muscle soreness	
o Diabetes	
o High or low blood pressure	
o Blood in urine	
o Shortness of breath	
o Sleep problems	
o Snoring	
o Asthma	
o Chronic hay fever	
o Chronic sinusitis	
o Drug allergies	
o Food allergies	
o Is there an unlisted medical problem I need to know about?	

What medication is patient taking?

Patient or Guardian_____

Figure 1:2: General health questionaire.

Please encircle the patient's:

Activity level Low Medium High
(active periods contrasted to inactive times)

Distractibility Hard Medium Easy
(easy versus hard to distract)

Intensity low Medium High
Energy level (loudness in actions)

Regularity Regular Medium Irregular
(biological functions - sleep, eating, bowel functions)

Sensitivity threshold Insensitive Medium Sensitive
(sensitivity to tight shoes, scratchy clothes, bright lights, loud noises, smells, tastes, etc.)

Approach/withdrawal Responds Medium Withdraws
(usual response to new situations, people, food, etc.)

Adaptability Easy Medium Poor
(ability to switch to new activity)

Persistence Low Medium Stubborn
(stubbornness or tenacity)

Mood Optimistic Medium Serious
(pleasant, optimistic, joyful contrasted to serious, somber)

Special interests or hobbies of patient

Figure 1:3: Temperament assessment.

Clinical Examination

Once these preliminary features of the examination are completed, the doctor can begin in earnest the clinical examination that will list the problems found in the mouth, face and head. Orthodontists have a tendency to rely too much on the records they take to the exclusion of the physical examination—a major error. In fact, no set of records can ever gather the quantity or quality of information available while the patient is in the examination chair. Muscle strains, oral hygiene, the dynamic relationships between the jaws, static occlusal relationships and gingival conditions are assessed much better at the chair than with any collection of secondary data such as X-rays, models, photographs and articulator settings. Clinicians would do well to use orthodontic records to confirm the diagnosis, not to make it. One special aid that helps view the entire maxillary arch at the initial examination, as well as during treatment, is a compact mirror that permits a view of the entire arch instead of individual teeth (Figure 1:4).

Figure 1:4: Doctor using a compact mirror to view entire maxillary arch.

The Problem List

Making a problem list[5] in a systematic manner will limit the omissions that often mar collection of data during the clinical examination (Figure 1:5). Following the completion of a problem list, one can make an accompanying solution list and then follow with a sequence of treatment that will describe exactly how the treatment will proceed.[5] The problem list, problem and solution lists and the treatment sequence can be automated and combined with other important patient information by using a database.

Oral Examination and Problem Listing

Angle Classification

Chief Complaint (Patient's Words)

Chief Complaint (Clinical)

Clinical and X-Ray Evaluation
Ectopic
Caries
Decalcification
Missing
Ankylosed
Retained
Non-Vital
Root Resorption
Atypical Form
Stains
Supernumerary
Impacted
Pathology
Dilacerated Roots
Osseous Loss

Clinical Teeth Relations
Maxillary Crowding
Maxillary Excess Space
Mandibular Crowding
Mandibular Excess Space
Midline Deviation
Overbite Severe
Open bite
Overjet
Underjet
Posterior Crossbite
Anterior Crossbite
MDFL Mand. Incisor Discrepancy

Orofacial Habits
Tongue Thrust
Snoring
Nail Biting
Digit Sucking

Face and Soft Tissue
Cant of Occlusal Plane
Mentolabial Fold
Interlabial Gap Nose
Lips Thick
Nasiolabial Angle
Resting Lip Incisor Length
Lips and Facial Profile Max
Lip Length
Smile Line
Lip and/or Palatal Cleft Abnormal
Maxillary Frenum Abnormal
Mandibular Frenum Obstructed
Nasal Airway
Enlarged Tonsils and/or Adenoids
Tongue Posture
Gingival Recession
Gingivitis
Periodontal Bone Loss
Oral Hygiene
Speech Impediment

Cast Analysis
Max Transverse Asymmetry
Mnd Transverse Asymmetry
Max AP Asymmetry
Mnd AP Asymmetry
Curve of Spee
Max Arch Length Discrepancy
Mnd Arch Length Discrepancy
Max Tooth Size Discrepancy
Mnd Tooth Size Discrepancy
Maxillary Spacing
Mandibular Spacing

Cephalometric Evaluation
Maxillary Incisors
Mandibular Incisors
Maxilla length
Mandible length
AP Discrepancy
Anterior Face Height
Vertebral Evaluation

TMD Evaluation
Joint Noise
Muscle Pain
Frequent Headaches
TMJ Tenderness
Restricted Right Lateral Motion
Restricted Left Lateral Motion
Restricted Translatory Motion
Restricted Protrusive Motion
Bruxism
CoCr Discrepancy

Figure 1: 5: Oral examination and problem list.

Database Management of the Problem List

FileMaker Pro is a popular database program made for Macintosh and PC by Claris Corporation that gives the user sophisticated information management without the help of a programmer. The samples within this packet are nothing more than a database system designed for the orthodontic office that simplifies and organizes the collection of patient data. Most of the information is collected at the initial patient examination and automatically stored within the database in specific files. Many companies now make such programs.

The systematic automation of this data allows us to do the following quickly:

- complete correspondence to the referring doctor and/or patient;
- print the various financial options for patient selection;
- print a problem list;
- make a problem and solution list and a sequence of treatment that will be followed.

The advantages of this database system are many:

- it automates many tasks and permits one person to complete what ordinarily requires two or three;
- it provides a clear, legible plan of treatment that everyone can read and understand;
- it obviates forgetting to list some of the problems and solutions on the treatment sequence.

The Patient Diagnosis and Treatment Chart

Most of the information gathered at the patient examination is placed either physically or electronically on a chart that will be available at each patient visit. Without much doubt, the future favors the electronic chart, but most orthodontists still have more comfort and confidence with a paper chart of some design that permits them to write what was done at the patient's appointment and what will be done at the next appointment. Some will even make this paper chart an envelope that contains all of the patient's records, which although efficient is quite unwieldy, particularly when transported to satellite offices.

I prefer a simple four-page patient chart made of thick paper which contains a front page that has space for personal data, the VTO, the problem list, the problem and solution list and the sequence of treatment. At the top of this first page is an area for a photograph of the patient and parent It is unreasonable to expect any employee to remember all of the patients and parents, and this will ease employees' tension as they try to respond to patient problems over the phone or identify a parent in the reception area.

A large section at the top of the first page is devoted to a space that permits printing in large block letters the patient's full name so that it can be read from any part of the room when the chart is placed in the chart holder at the patient chair. People like to hear their names, and this permits employees to use a patient's name in an easy, natural manner that creates a friendly, comfortable environment. Part of the first page is devoted to a section that grades patient compliance, another to record procedures done and another for what is planned at the next visit.A small column is available to record the initials of the assistant who worked with the patient, and the last column includes the date and time of the next appointment.

The receptionist often needs all of this information as she responds to requests to change appointments, schedule emergency appointments and counsel patients or parents over the phone. She can often save patients from having to come to the office for an emergency appointment by judicious use of information on the front page.

The second page contains the general health questionnaire, the temperament survey and the problem list questions. Since implementing the electronic database, I have not used the paper and pencil problem survey, but this remains a good starting point for those who would develop their own patient problem list.

The third page is blank and serves as a vehicle for carrying the 1:1 sized photos of the patient's mouth and face and also a photograph of the panograph. Such a small photo of the X-ray would never be diagnostic, but it certainly shows whether teeth are present, absent or impacted and reveals many other features the clinician is likely to forget without some visual reminder. This simple and inexpensive idea eliminates having to carry the X-rays in the patient chart and running the great risk of losing such an important document. The biggest defect of the paper chart is the inability to store multiple images of the mouth efficiently. Orthodontists will do themselves and their patients a great favor by taking, storing and retrieving images of the stages of treatment. For this task nothing short of an electronic system will suffice.

The fourth page is simply another page to record patient treatment Orthodontists will eventually convert to electronic charts, which stores all the patient information, but it may be a while before it happens universally.

Section II: Systems Analyses

Skeletal Analysis

The growth potential of patients is one of the most important pieces of information orthodontists can have. Bjork and Skeller[6] developed the interpretation for the hand-wrist X-ray, and it remains the most accurate assessment we can use for determining skeletal age. Unfortunately, it requires an additional X-ray, extra time , more expense, and many patients and parents object to the additional radiation.

Lamparski[7] developed a reasonable alternative to the hand-wrist X-ray that uses the lateral cephalogram which most orthodontists already have as part of their records.[7] Lamparski discovered that the cervical vertebrae accurately reflect the skeletal age, and he subsequently developed standards for male and female patients. Those standards are included in this explanation (Figures 1:6,1:7). Work by Garcia-Fernández[8] and others has augmented that of Lamparski and is also included here (Figure 1:8).

Although this vertebral analysis does not have the precision of the hand-wrist x-ray, it is accurate for determining if patients will grow for six, twelve or more months during their treatments. That is ordinarily adequate for determining if a cervical retractor will have an orthopedic effect or if a functional appliance will have anything but dentoalveolar consequences. Orthodontists simply need to know if the patient will grow, and if advantage can be taken of that growth.

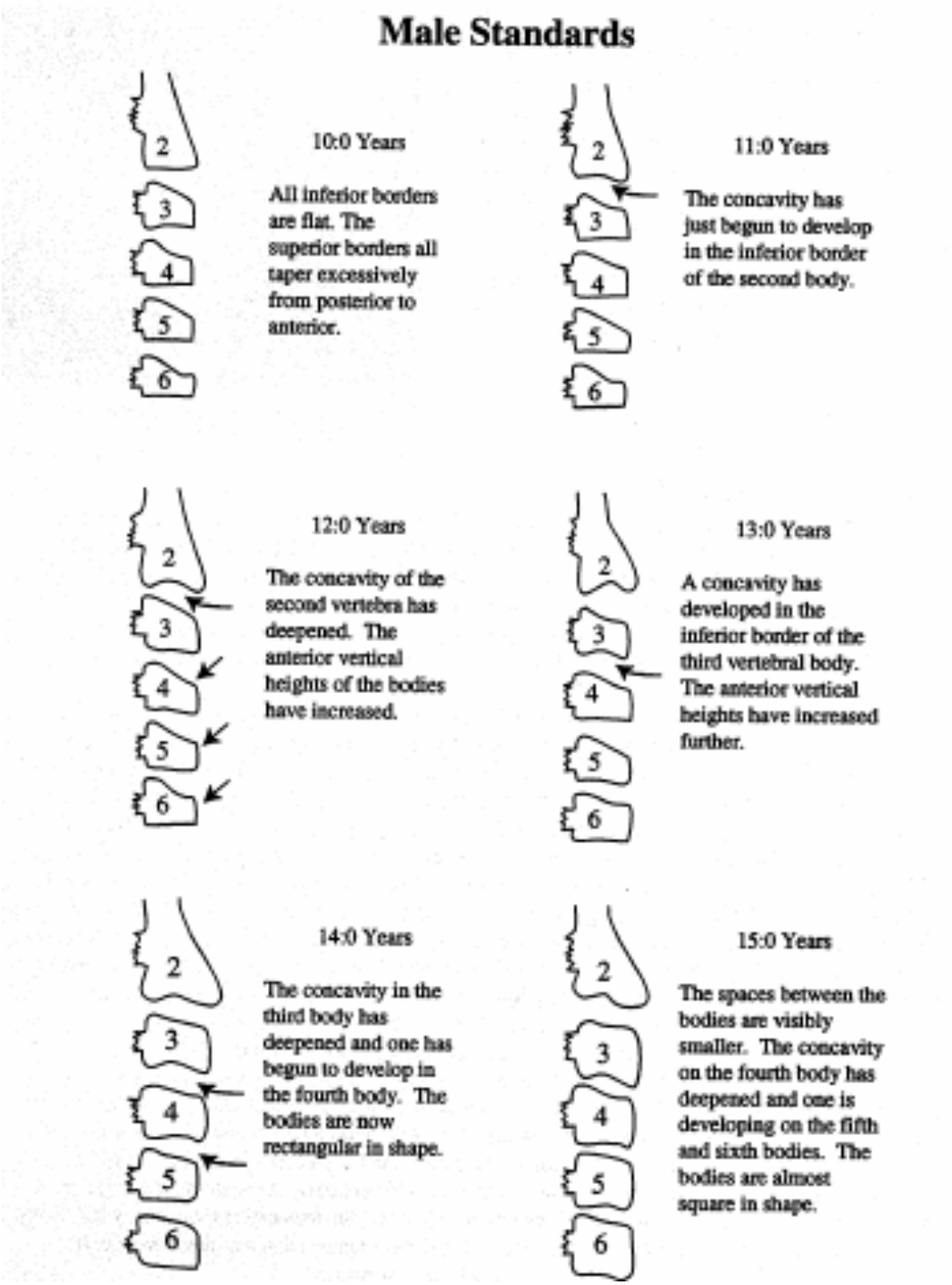


Figure 1:6: Lamparski male standards

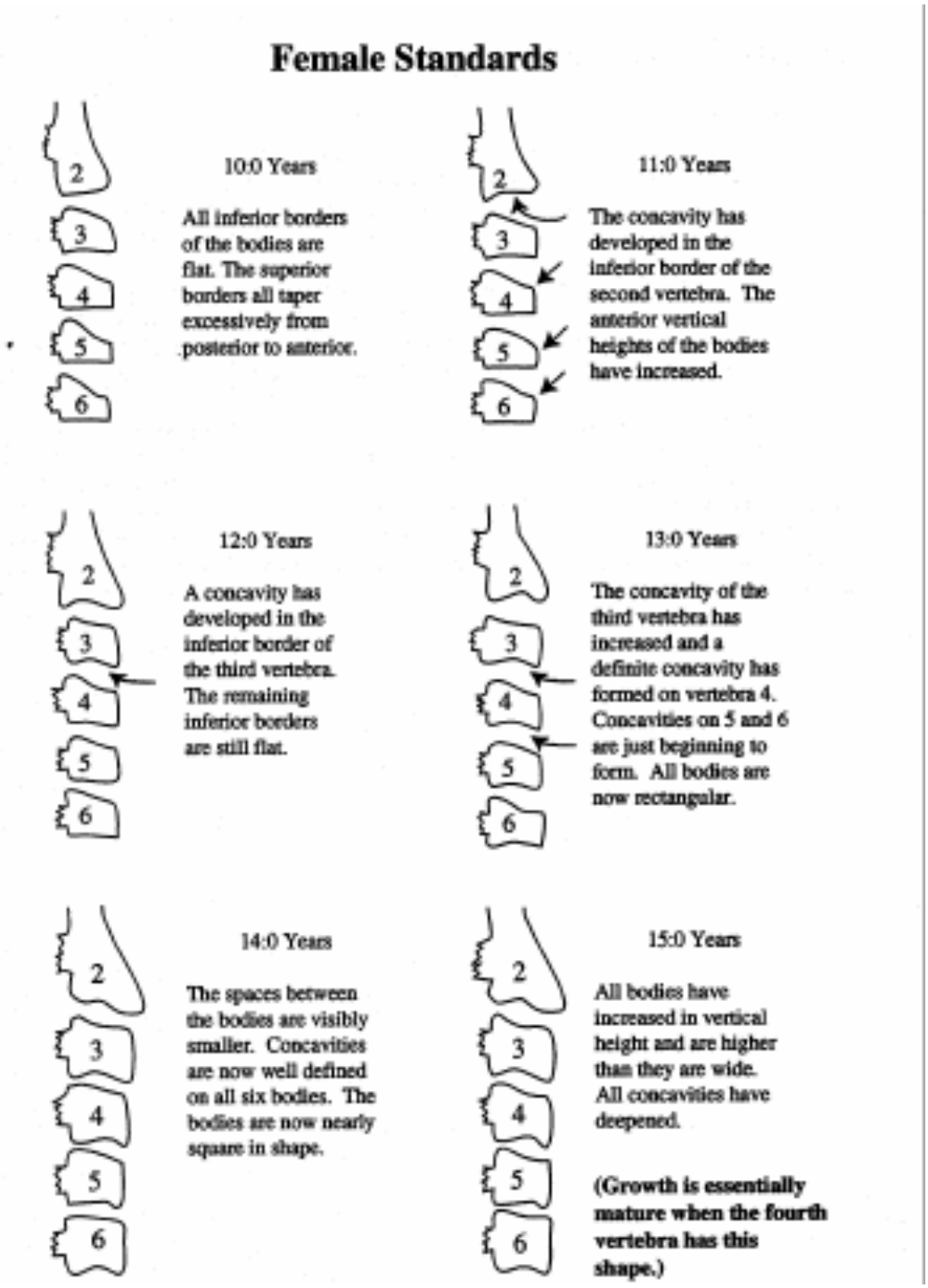


Figure 1:7: Lamparski female standards

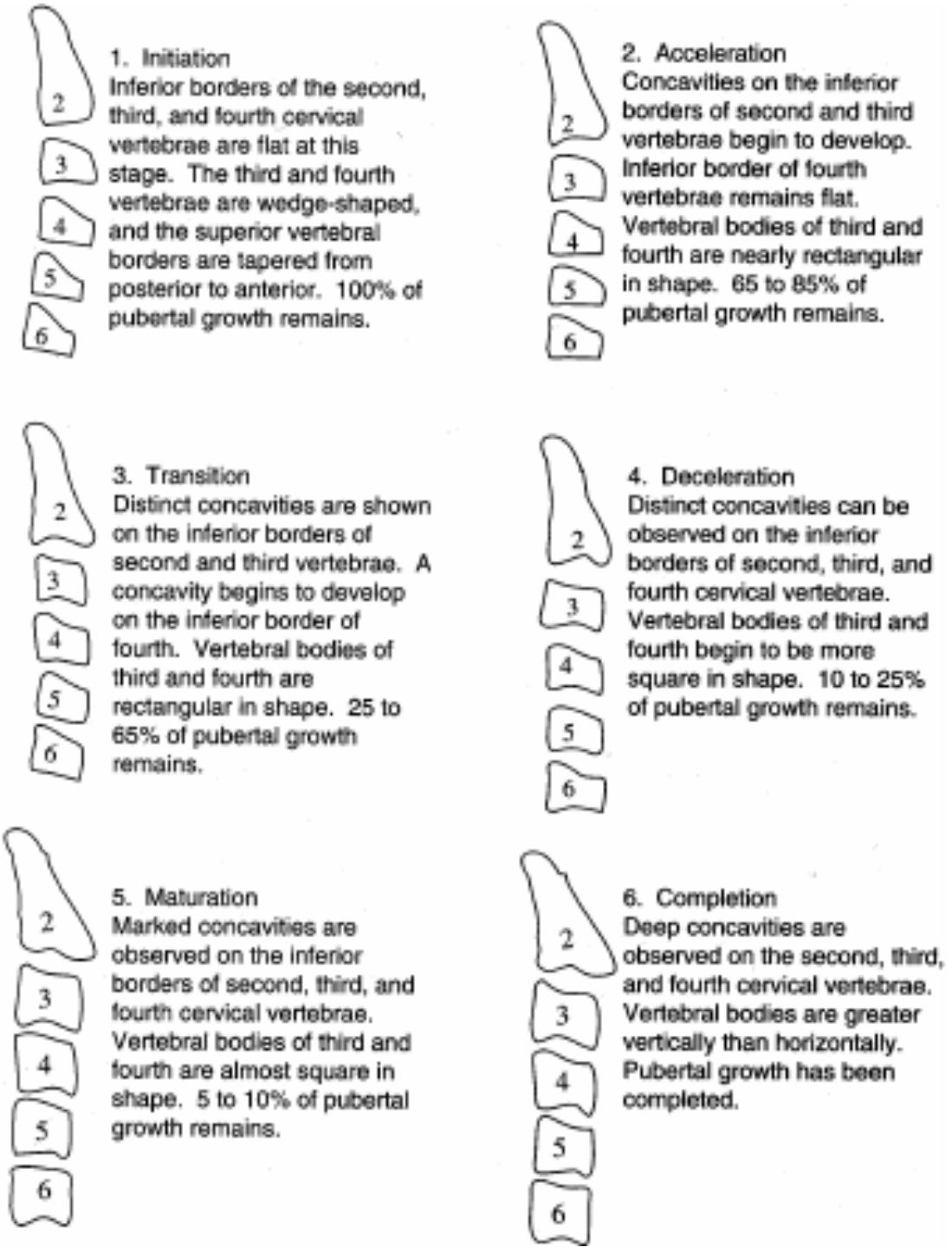


Figure 1:8: Garcia-Fernandez Vertebral Standards

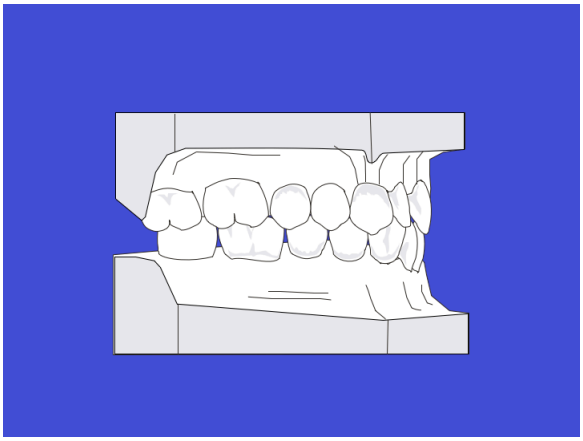
Soft-Tissue Analysis

A soft-tissue analysis involves an assessment of the gingiva, adenoids and tonsils as well as the tongue, lips, forehead, nose and chin. The role played by enlarged tonsils and adenoids in open bite and tongue thrust patients is well documented and will not be discussed in detail here.[9] Nevertheless, whenever orthodontists suspect these tissues may limit their orthodontic success, they need to encourage a medical consultation with an otolaryngologist to see if the removal of that soft tissue can aid in the resolution of the malocclusion (Figure 1:9)

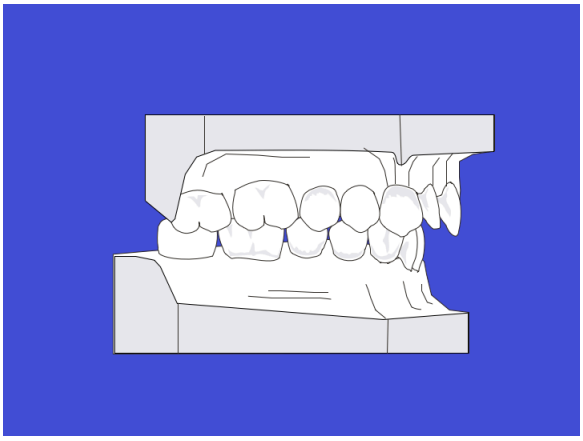
Figure 1:9: Tonsils and adenoids are outlined with dotted lines.

Orthodontic Classification

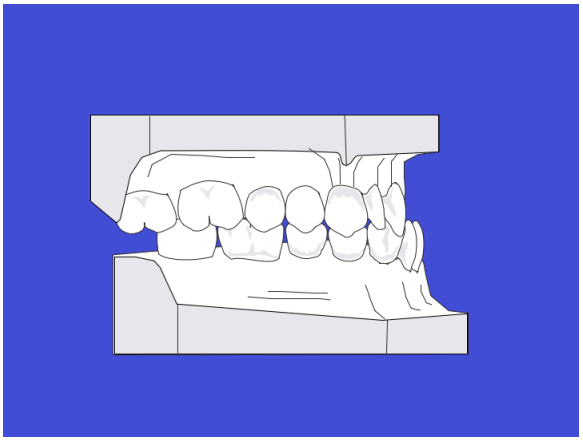
Anyone with even a rudimentary knowledge of orthodontics understands the Angle classification of malocclusions, e.g., Class I, Class II and Class III. Less well-known are the subdivisions, which will have one-half of the dentition with one occlusal arrangement and the other half with another. For example, a Class II malocclusion with one side Class I is known as a Class II subdivision. Unfortunately, orthodontics has never developed classifications for those malocclusions that require therapy but are in between definite boundaries, i.e., the patient who exhibits a malocclusion that isn't a frank Class II but displays less than firm Class I occlusion. Clinicians will serve themselves and their patients best by considering these malocclusions as Class II.



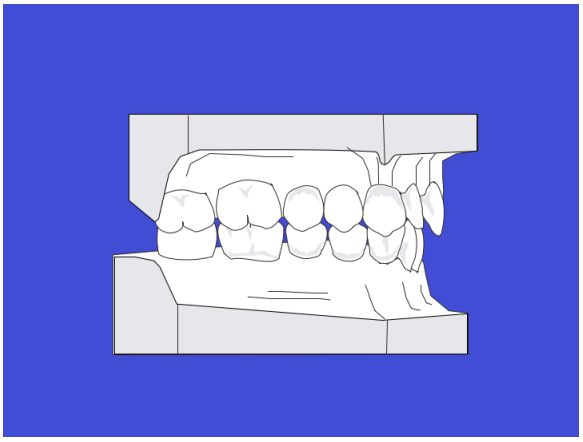
Class I Occlusion.



Class II Occlusion.



Class III Occlusion.



Class ? Occlusion.

One additional malocclusion that clinicians need to know is the Pseudo Class I that DeBaets and Chiarini defined.[9-11] It differs from the classical Angle Class II malocclusion by having mesially rotated maxillary molars and crowded mandibular incisors; but since it lies between a Class I and a Class II malocclusion, clinicians should consider it a mild dental Class II malocclusion. Patients usually have at least three of the five following features:

1. mesial rotation of the maxillary molars;
2. crowding of the mandibular incisors;
3. mesial eruption of the mandibular canines due to a lack of space
4. overerupted mandibular second molars;
5. deep anterior overbite.

The keys to intercepting this camouflaged Class II malocclusion before it manifests lie in proper diagnosis and timely therapy. Clinicians need to place a mandibular lingual arch before the loss of the mandibular second primary molars. This will prevent mesial movement of the molars and lingual movement of the incisors and will give space for the mandibular canines to drift distally spontaneously. Simultaneously, the maxillary molars need distal rotation by some means, e.g., headgear, transpalatal arch, quad-helix or arch wire with brackets and tubes, etc.

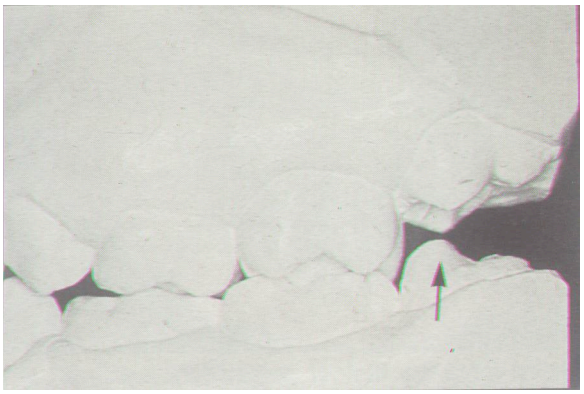
Readers can find complete articles that describe the Pseudo Class I malocclusion and therapies on my website (www.larrywwhiteddsmsd.com) Lectures -Pseudo Class I - Username, orthotx; Password, orthotx.

Crowded mandibular incisors.

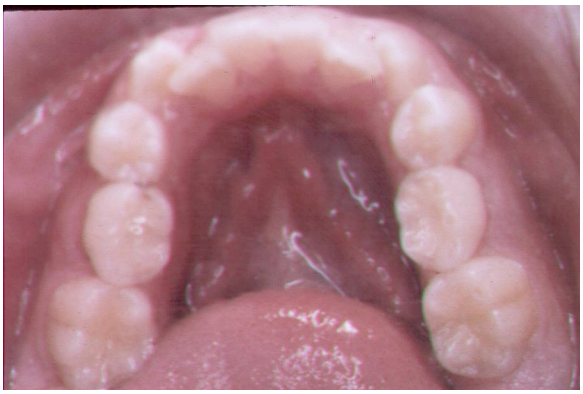
Deep overbite.

Mesially erupted mandibular canines.

Mesially rotated maxillary first molars.



Overerupted mandibular second molar.



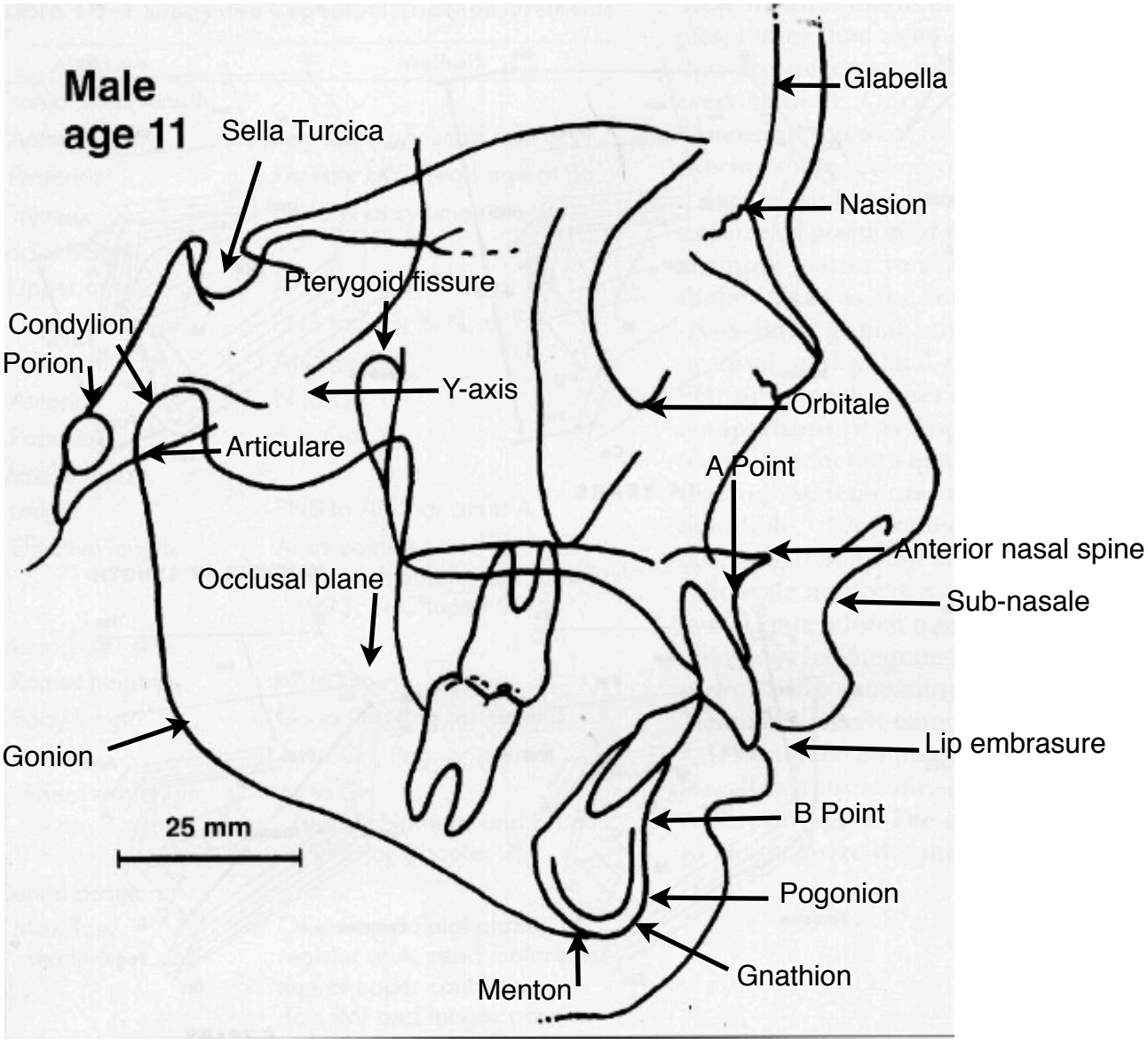
Pseudo-Class I mandibular arch.

Maxillary arch after intervention with maxillary 2 x 6 bonding.

Spontaneous alignment after placement of lingual arch and loss of second primary molars.

Cephalometric Review

Cephalometric Landmarks



A-point - The deepest midline point on the curvature of the maxilla.

Anterior Nasal Spine (ANS) - the bony process of the maxilla at the lower margin of the anterior nasal opening, which separates the upper from the lower face.

Articulare (Ar) - A constructed point where the inferior surface of the cranial base and the posterior outlines of the ascending rami meet.

B-point - The deepest midline point on the bony curvature of the anterior mandible.

Condylion (Co) - The most superior posterior point on the head of the mandibular condyle.

Glabella (G) - The most prominent point of the anterior contour of the frontal bone in the midsagittal plane.

Gnathion (Gn) - The most anterior inferior point on the bony chin in the midsagittal plane.

Gonion (Go) - The most posterior inferior point on the outline of the angle of the mandible.

Menton (Me) - The most inferior point of the mandibular symphysis in the midsagittal plane.

Nasion (N) - The intersection of the internasal and frontonasal sutures in the midsagital plane.

Orbitale (Or) - the lowest point on the inferior orbital margin.

Pogonion (Pg) - The most anterior point on the contour of the bony chin in the midsagittal plane.

Porion (Po) - The most superior point of the external auditory meatus.

Posterior Nasal Spine (PNS) - The most posterior point on the bony hard palate in the midsagittal plane.

Pterygomaxillary Fissure (PTM) - A teardrop-shaped radiolucency, whose anterior border represents the posterior surface of the tuberosity of the maxilla.

Subnasale (Sn) - The point in the midsagittal plane where the base of the columella of the nose meets the upper lip.

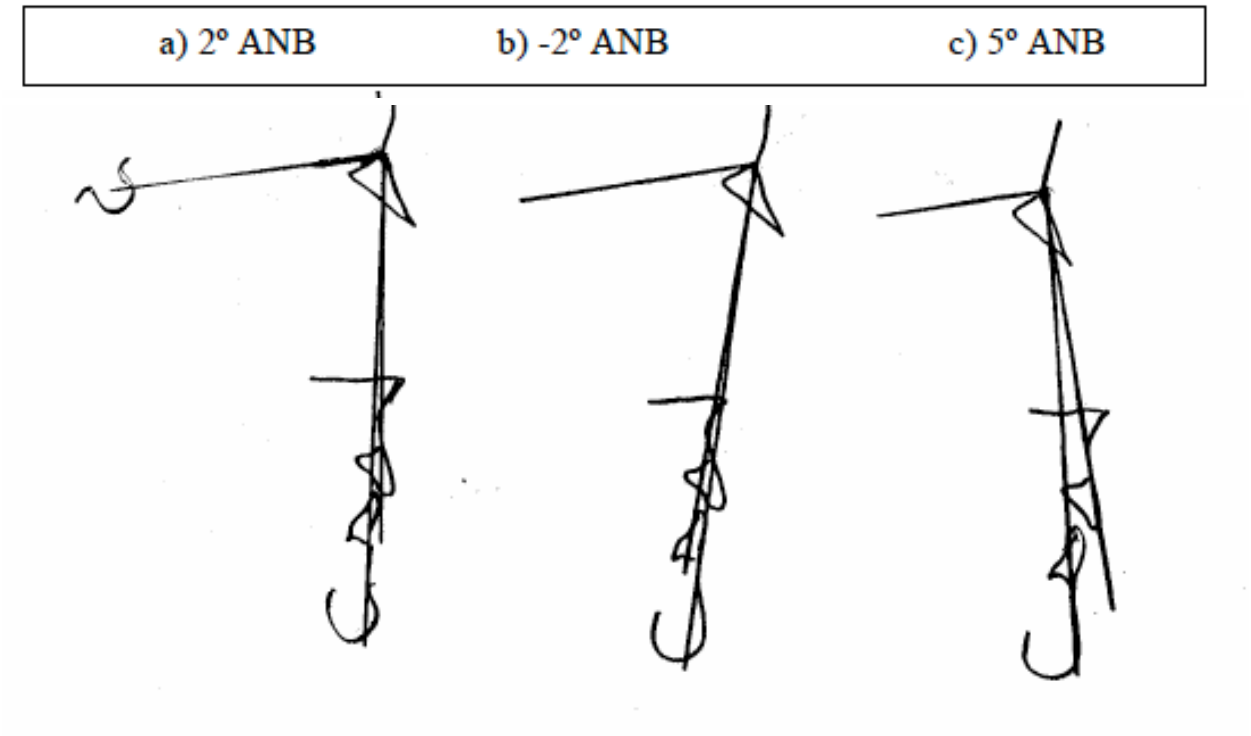
Y-axis (Growth axis) - A line connecting sella and gnathion.

Cephalometric Analysis

Downs[27,28] developed the first analysis to interpret the cephalogram and to give orthodontists an instrument to plan treatment based on developed norms. Unfortunately, these norms came only from a limited number of adolescent female Caucasians. Subsequent studies have developed more age, race and gender-specific cephalometric data for use in diagnosis and treatment planning. The most popular cephalometric analyses and treatment planning systems have been the Tweed Triangle,[12,13] the Steiner Analysis,[14,15] the Williams APo line[16] and the Visual Treatment Objectives by Ricketts[17,18] and Holdaway.[19,20]

I prefer a simple cephalometric analysis for Caucasians that measures only a few dimensions. The basis of this cephalometric analysis resides in positioning the patient in true horizontal while making the image. This is the way we habitually view people, and any reasonable esthetic assessment must start from this natural position of the head.

Clinicians have used SNA, SNB and ANB extensively since their introduction by Downs[27,28] and Riedel[35] to assess the sagittal difference between the maxilla and mandible, but they have more historical than practical use, since the angulation and/or length of the cranial base can cause serious misinterpretations of these measurements (Figure 1).



Effect of a) normal length cranial base, b) long base and c) short base.

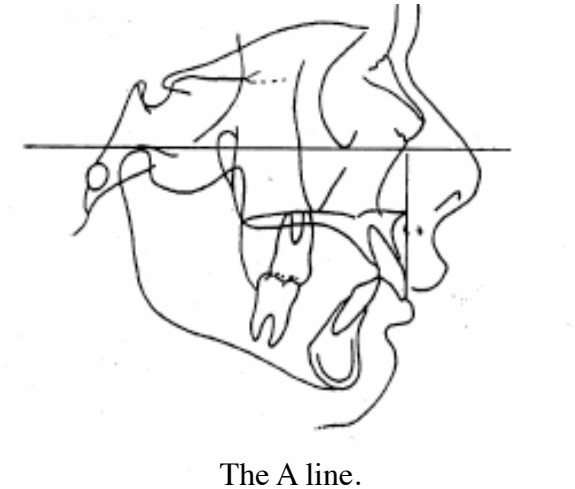
To assess the difference in sagittal distance between the maxilla and mandible, I prefer perpendicular lines drawn from true horizontal to points A and B as suggested by Cooke.[32,33] The average distance between A and B is 4mm, but the normal range has a wide variance and can extend from -1 to +10mm..

Measuring A-B sagittal discrepancy.

I want to know the relative lengths of the maxilla and mandible as suggested by Harvold, [30]and I also want to know: the anterior face height he recommended, since the forward or backward rotation of the mandible often dictates how I approach treatment. The anterior face height has more sensitivity and relevance than the mandibular plane angle and alerts us to the difficulty or ease of opening or closing the overbite of a patient.

Maxillary and mandibular lengths and anterior face height.

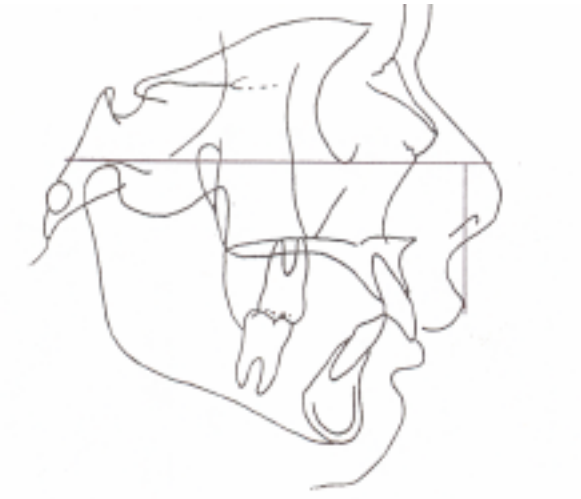
I also measure the maxillary incisor to the A line suggested by Alvarez[29] and the NA line suggested by Creekmore.[31] The A line is a perpendicular line drawn from true horizontal through a point 1/3 of the distance between soft tissue A point and hard tissue A point. A correctly positioned maxillary central incisor will lie exactly on that line ± 1mm. The NA line should bisect the mandibular incisor ± 1mm, and the maxillary incisor should lie 4-5mm anterior to it.



The A line.

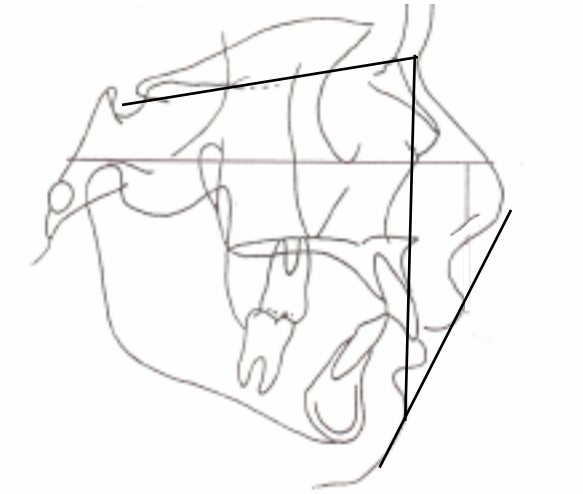
The NA line.

One of the most important features of the tracing comes from an esthetic line proposed by Holdaway,[19,20] and it measures the depth of the subnasale from a perpendicular line drawn from true horizontal to the outer contour of the upper lip. The normal range of this measurement for Caucasians runs from 2mm to 4mm. When this distance measures 2mm or less, clinicians must carefully design their therapy so as not to retract the maxilla or maxillary incisors. Five millimeters of sulcus depth or more usually indicate the need to reduce the protrusion of the maxilla or maxillary incisors.



Subnasale depth.

H line.



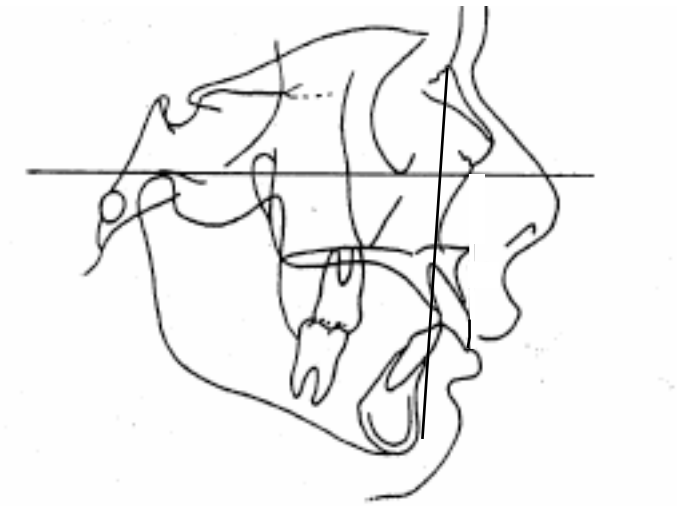
H angle.

Table 1.

Convexity	H angle
-5mm	5°
-4mm	6°
-3mm	7°
-2mm	8°
-1mm	9°
0mm	10°
1mm	11°
2mm	12°
3mm	13°
4mm	14°
5mm	15°
6mm	16°
7mm	17°
8mm	18°
9mm	19°
10mm	20°

The harmony line or H line measures the distance from the sub-nasale to a line drawn from the soft-tissue pogonion to the contour of the upper lip. Caucasians with good lip contour will usually measure at or near 5mm, but this distance can vary from 3mm to 7mm depending upon the thickness of the lip. Buschang et al.[34] has discovered the relevance of this measure vis á vis other soft-tissue measurements

The skeletal convexity measures the amount of protrusion or retrusion the maxillary arch displays in relation to forehead and the chin and is measured in millimeters from a line drawn between nasion and pogonion to A point on the maxilla.



Skeletal convexity.

I want to assess the inclination of the maxillary central incisor whose axial line should run through the distal of the orbit. Finally, the occlusal plane should bisect the maxillary and mandibular molars and also the maxillary and mandibular incisors. All the measurements used in the White analysis are displayed below. Several computer programs exist that automate the construction of cephalometric tracings, Visualized Treatment Objectives and multiple analyses. Without much doubt, these programs can save considerable amounts of time and standardize one of the mundane but necessary tasks of the orthodontic diagnosis and treatment planning after a short learning period.

Maxillary incisor angulation.

Occlusal plane.

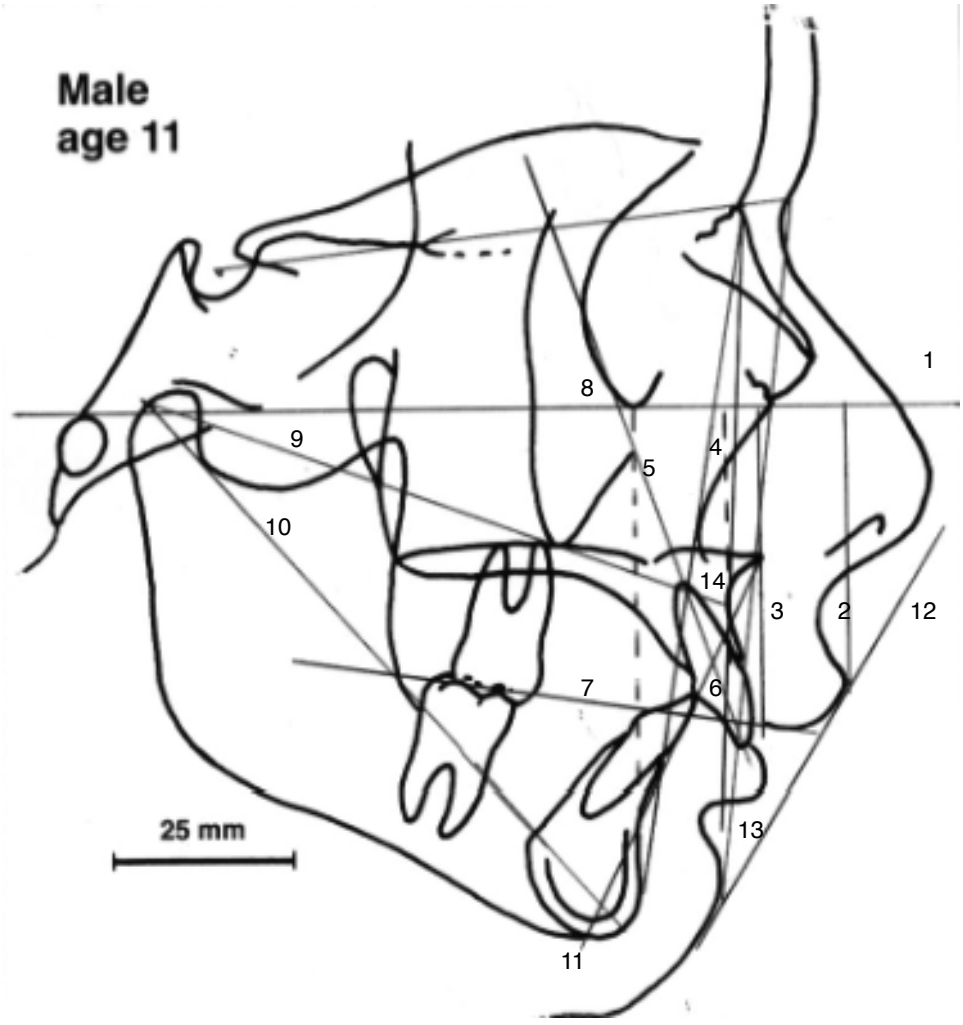


Figure 12: White's Cephalometric Measurements

Table 2 contains the Harvold norms for Caucasians, while Table 3 shows the ranges of the measurements in the White analysis. Tables 4 and 5 show measurements for African-American adolescent males and females using Creekmore, Holdaway and Alvarez computations. Those measurements have a greater range than do the Caucasian norms, and rather than retracting on a 1:1 basis, the African-American upper lip, as other patients with thick labial integument will ordinarily retract only about one-third as much as the teeth. No precise and narrow formula for maxillary incisor placement now exists for these patients, and the range of optimal measurements has proven unusually broad. The average of most of the measurements for soft-tissue profile, maxillary convexity and maxillary and mandibular incisor positions were at least twice or more than those for Caucasians, and the range of those normal measurements was also much greater.

The clinical implications discourage too much reliance on soft-tissue limits and encourages more dependence upon the clinical examination, arch length discrepancies, tooth size discrepancies and patient desires to arrive at a reasonable treatment plan for the African-American patient and others with thicker labial integument.

White's Cephalometric Measurements

This system of cephalometric measurements depends upon taking the image with the patient in a natural head position with the eyes looking straight ahead. The head cannot be tilted up or down, otherwise the measurements will be wrong. The patient should have the lips together so that clinicians can assess the amount of lip strain and allow the accurate placement of a new occlusal plane for development of a Visualized Treatment Objective.

1. Draw a horizontal line perpendicular to the right side of the image and just beneath the orbit. This is True Horizontal.
2. Draw a line perpendicular to True Horizontal that just touches the outer contour of the upper lip and measure in millimeters from that line to the concavity of sub-nasale.
3. Measure the distance between soft-tissue A point to hard-tissue A point and divide that distance into thirds. Draw a line perpendicular to True Horizontal that runs through the one-third point nearest to hard-tissue A point. This is the A line.
4. Draw a perpendicular line from True Horizontal through hard-tissue A point.
5. Draw a perpendicular line from True Horizontal through hard-tissue B point and measure in millimeters the distance between the A and B lines. This is the A-B discrepancy.
6. Draw a line NA from nasion through hard-tissue A point and extend it down through the mandibular incisor. Measure in millimeters the distance from this line to the center of the mandibular incisor and to the facial surface of the maxillary central incisor. The line should pass through the center of the mandibular incisor ±1mm, and the maxillary incisor should lie 4mm ±1mm in front of the NA line.
7. Draw the occlusal plane so that it bisects the maxillary and mandibular molars and incisors.
8. Draw a line through the axis of the maxillary incisor and note how it relates to the orbit. An ideal position will put the axial line just distal to the orbit.
9. Measure from condylion to hard-tissue A point in millimeters.
10. Measure from condylion to hard-tissue gnathion in millimeters and calculate the difference between the maxillary and mandibular lengths.
11. Draw a line between the anterior nasal spine (ANS) and menton and measure this distance in millimeters.
12. Draw a line from soft-tissue pogonion to the outer contour of the upper lip and measure from that line to the concavity of sub-nasale. This is the harmony or H line.
13. Draw a line from the point where an extension of SN touches the soft-tissue of the forehead to the soft-tissue pogonion and measure the angle that line makes with the H line. This is the soft-tissue angle of convexity.
14. Draw a line from nasion to pogonion and measure the distance from that line to A point. This is the skeletal convexity.

	6yrs mm	7yrs mm	8yrs mm	9yrs mm	10yrs mm	11yrs mm	12yrs mm	13yrs mm	14yrs mm	15yrs mm	16yrs mm	17yrs mm	Adult mm
Females													
Mnd.Length Co-Gn	97	100	103	105	108	111	113	115	117	118	119	119	120
Mx Length Co-Pt A	80	82	84	85	87	89	90	91	92	92	93	93	93
Mx-Mnd Difference	17	18	19	20	21	22	23	24	25	26	26	26	27
ANS-Menton	57	58	59	60	61	61	62	63	64	64	65	66	67
Males													
Mnd Length Co-Gn	99	102	105	107	109	111	114	116	121	123	127	128	130
Mx Length Co-Pt A	82	84	86	87	89	91	92	93	96	97	100	100	100
Mx-Mnd Difference	17	18	19	20	20	20	22	23	25	26	27	28	30
ANS-Menton	59	60	61	62	62	63	64	65	68	69	71	71	72

Table 2: Harvold's Cephalometric Measurements for Caucasians

Upper lip sulcus depth 2 – 4mm
Maxillary 1 to A Line 0 ± 1mm
Maxillary 1 to NA 4mm ±1mm
Mandibular 1 to NA 0 ± 1mm
A – B difference -3 to +10mm
Co to A Age related (Harvold)
Co to Gn Age related (Harvold)
ANS to Menton Age related (Harvold)

Table 3: White's Caucasian Range of Normals.

VALUE	AFRICAN-AMERICAN ADOLESCENT MALE MEANS
Soft-tissue facial angle	84°± 3°
Skeletal profile convexity	81° ± 3°
Upper lip sulcus	7mm ± 2mm
Sub-nasale to H line	14mm ± 3mm
H angle	23° ± 4 °
Lo lip to H line	4mm ± 2mm
A-B difference	6mm ± 4mm
A line	2mm ± 2mm
APo line to lo incisor	6mm ± 3mm
Lo 1 to NA line	3mm ± 3mm
Up central incisor from NA	7mm ± 2mm
Convexity	5mm ± 2mm

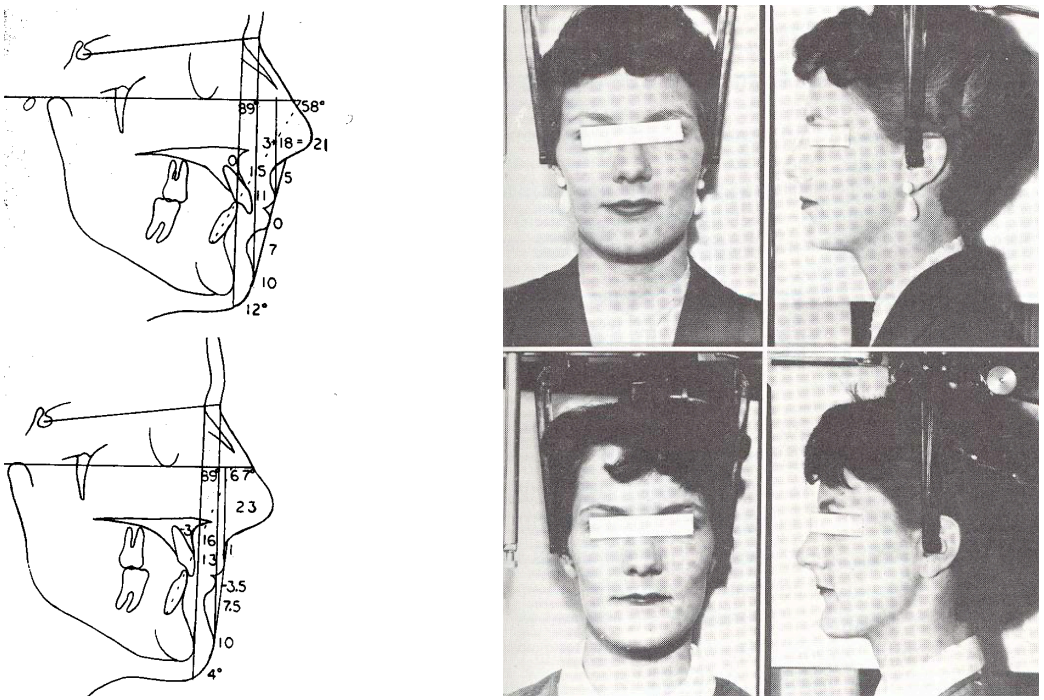
Table 4: African-American Adolescent Male Means.

VALUE	AFRICAN-AMERICAN ADOLESCENT FEMALE MEANS
Soft-tissue facial angle	85°± 2°
Skeletal profile convexity	82° ± 3°
Upper lip sulcus	7mm± 3mm
Sub-nasale to H line	12mm ± 2mm
H angle	21° ± 2°
Lo lip to H line	3mm ± 2mm
A-B difference	5mm ± 4mm
A line	2mm ± 2mm
APo line to lo incisor	5mm ± 2mm
Lo 1 to NA line	2mm ± 3mm
UP central incisor from NA	7mm ± 2mm
Convexity	5mm ± 2mm

Table 5: African-American Adolescent Female Means.

Cephalometric Soft-Tissue Analysis

Charles Tweed[12,13] gave orthodontists their first cephalometrically-derived treatment planning instrument – the Tweed Triangle – which favorably placed the mandibular central incisors within the confines of the anterior alveolar cortical plates. The rest of the dentition was then arranged to fit these mandibular incisors. Tweed felt that ideally positioned mandibular central incisors had a 90º angulation ± 3º to the mandibular plane. Practically all subsequent cephalometric treatment planning schemes drew from Tweed's idea of first positioning the mandibular central incisors and then arranging the rest of the dentition to correspond to these teeth. The Steiner Analysis,[14,15] Williams APo line[16] and Rickett's Visualized Treatment Objective[17,18] may have differed as to the position of the mandibular incisors, but all of them based their cephalometric treatment plans on the position of these teeth. Holdaway[19,20] was the first to suggest that since the maxillary central incisors determined lip posture, patients might receive better therapy if treatment planning started by determining where the lips should be at the conclusion of treatment. Rather than letting the relationship between mandibular central incisors and osseous tissue dictate the treatment plan and mechanics, Holdaway boldly suggested that clinicians should consider the effect their therapy will have on soft tissue. Ignoring this imperative can cause serious worsening of the profile and lip support as seen in the photos below. Few clinicians would consider the results of this therapy as beneficial for the patient's profile.

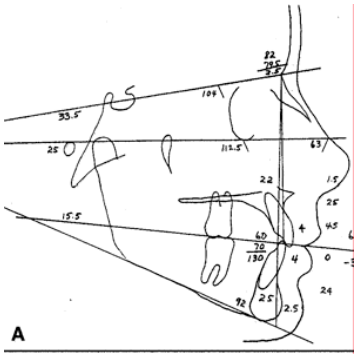


Before-and after-treatment cephalometric tracings and facial photographs dictated by osseous diagnostic landmarks. (From Holdaway, Am. J. Orthod. 84: 1, 1983.)

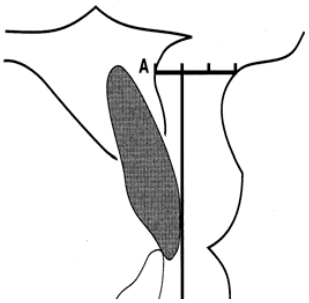
Perhaps Holdaway's most significant discovery was that, in Caucasians, the upper lip retracts exactly with the maxillary central incisors, with exceptions allowed for a few types of malocclusions and racial differences. Other authors have suggested differing clinical responses to maxillary incisor retraction, but the differences are attributable to the exceptional cases Holdaway mentioned and obvious racial differences in lip thickness. Despite whatever disagreement exists about the amount of movement treatment may produce on the maxillary incisors, hardly anyone now disputes the idea that lip posture and contour are, fundamentally, a function of maxillary central incisor position. So while there may not yet be a consensus about the amount of movement expected from therapy, simple acknowledgment of this incisor function warrants attention to the exclusion of hard-tissue determinants that have no direct relationship to lip contour. Without unanimous agreement about what to expect from treatment and subsequent positioning of the maxillary central incisors, clinicians might ask why they should rely on their placement in the face as a diagnostic and treatment planning instrument.

Holdaway used this knowledge of maxillary central incisor effect on lip curl to design his visualized treatment objective (VTO), which subsequently gave him the targets for positioning the teeth. Describing the Holdaway VTO or any other is beyond the scope of this paper, but readers should familiarize themselves with his technique by reading the original articles,[19,20] since all other VTO techniques have proceeded from that one. The significant difference between Holdaway and other methods of diagnosis and treatment planning is that maxillary lip form has replaced the mandibular central incisor position as the focus of our treatment planning.

When assessing the patient's cephalometric tracing for treatment planning guidance, I synthesize a decision based on the Creekmore[31] (Figure 12), Alvarez[29] (Figure 13) and Holdaway analyses. Much of the time these three analyses find a consensus, but when they differ substantially, I rely on the Holdaway analyses since it depends on the soft tissue exclusively, and that is what we ultimately consider when looking at someone.

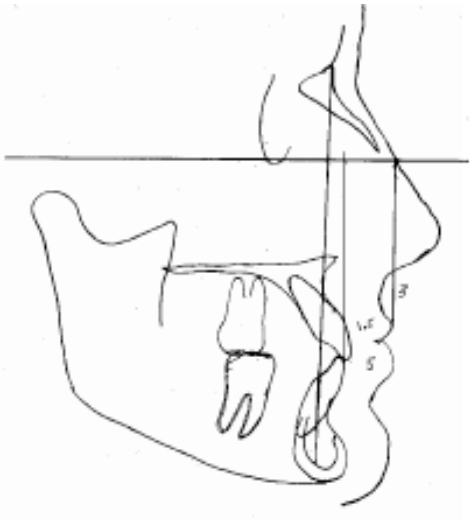


Creekmore analysis that positions the maxillary incisor 4mm± 1mm in front of NA line and the mandibular incisor on the NA line ± 1mm.



Alvarez A line that positions the maxillary incisor on the A line ± 1mm.

The patient below presents a disagreement among the three analyses I depend upon. The upper lip has an ideal lip sulcus of 3mm, while the maxillary and mandibular incisors are substantially advanced of the NA line, and the maxillary incisor is 1.5mm ahead of the Alvarez A line. With this patient I will use the Holdaway analysis and try not to change the position of the maxillary incisor.



Lack of consensus regarding diagnosis and
treatment planning.

Perhaps the best clinical advice for clinicians who would use the maxillary incisor for diagnosis and treatment planning is to evaluate their patients' personal treatments and techniques to determine what they routinely accomplish with particular facial types and malocclusions. This type of private study will give clinicians a much more specific idea of what to expect with a particular treatment design and should permit orthodontists to achieve more accuracy in their treatment forecasts. Clinicians should not consider the Holdaway, Creekmore or Alvarez treatment-planning techniques infallible or the only analyses necessary in deriving a diagnosis and treatment plan. However, they do place a diagnostic and therapeutic emphasis on the dental feature most responsible for lip contour and facial appearance, i.e., the maxillary central incisor.

In summary, all the analyses discussed have at least some basis for existence and usefulness. Nevertheless, the restricted use of only one analysis can give the clinician an unwarranted confidence that inevitably leads to serious esthetic and functional errors. Although the reliance on a single analysis brings a certain amount of intellectual comfort to the orthodontist, such exclusivity can be compared to the certainty of having a single clock. If we have one clock, we know what time it is. If we have two clocks, we do not know what time it is. If we have ten clocks, we learn how difficult it is to tell time, but that is what science,i.e., orthodontics is about.

Radiographic Analysis

Many X-rays are available that can assist orthodontists in knowing what lies below the visible surface. Some clinicians prefer periapical views of the teeth to panoramic ones. Others may want to supplement their full-mouth survey with bite-wings, tomograms and TMJ views. Many orthodontists also insist on a posterior-anterior cephalometric view to complement the lateral cephalometric image that orthodontists commonly use. I prefer to use a minimum of X-rays consistent with making an accurate diagnosis, and I typically take a lateral cephalometric view, panograph and bitewings. From time to time, periapical images of the teeth are needed and TMJ images, or cone beam computed tomograms; but they are not a part of my routine X-ray analysis. Although the radiation contained in dental X-rays would almost never reach a dangerous level, prudent dentists will minimize the amount of radiation delivered to patients.

Photographic Analysis

One of the time-honored ways of objectively evaluating the face and mouth is to rely on photographs that orthodontists may refer to during a treatment. The most common and best quality camera is a single lens reflex digital (SLR) camera with a macro lens, circular strobe light around the lens, and a point flash for portrait photographs. Other less expensive cameras are available, but the SLR offers the most fidelity.

Complete Orthodontic Photograph Collection

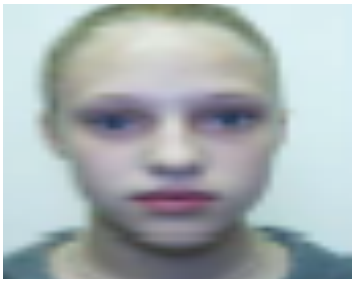
A complete orthodontic collection of photographs usually consists of eight images:

- a full face photograph of the patient's head with the lips at rest;
- a full face photograph of the patient smiling;
- a profile of the patient's head with lips at rest;
- an intraoral close-up of the right side of the mouth with the teeth in occlusion;
- an intraoral close-up frontal view of the occlusion;
- an intraoral close-up of the left side of the mouth with the teeth in occlusion;
- an intraoral occlusal view of the teeth in the maxilla;
- an intraoral occlusal view of the teeth in the mandible.

Each of the following photographs shares some common photographic needs, but they also have some that are peculiar for them alone.

The facial profile view needs a good frontal flash with a white background illuminated with a slave-light that leaves no shadows. This image should focus on the patent's ear and frame only from the top of the head to the bottom of the neck. The hair should be pulled back of the ear and none of the hair should interfere with a good image of the face. The head should look straight ahead with a true horizontal orientation. The eyes should remain open without corrective lenses in place. The lips should be together and relaxed. Lip incompetence may give a strained facial appearance, but this will alert the doctor to an important diagnostic feature.

The full-face solemn view requires a good frontal flash with a white background illuminated with a slave light back flash that leaves no shadows. This image should focus on the eyes and frame only from the top of the head to the bottom of the neck. The hair should be back so as not to interfere with exposure of the face and ears. The head should look straight ahead with a true horizontal orientation. The eyes should not have glasses and remain open. The lips should be together and relaxed. Lip incompetence may give a strained facial appearance, but this alerts the doctor and is an important diagnostic feature.



The full-face smiling portrait requires the same kind of frontal and backlighting as the other facial photographs and is framed in the same manner from the top of the head to the bottom of the neck. A true horizontal orientation remains in force, and the smile should be maximum to show the largest amount of gingiva exposed during the smile .

The right and left intraoral photos can be taken with a direct view through the camera or with a side mirror. Each technique has advantages as well as disadvantages. Small mouths do not tolerate the mirrors well, and that prevents taking a good photograph; but often a direct shot will not get enough of the teeth to view the entire posterior occlusion. Mirrors will need warmth to keep from fogging in the mouth. This can come from either hot water or storage in the warming pocket of a heating pad.

Regardless of whether a mirror is used for these views, some principles need emphasis such as:

- the patient should bite the teeth together in centric occlusion;
- the side being photographed will need to be pulled back maximally, while the other side is pulled back minimally.
- this view should display teeth from the distal of the maxillary lateral incisor to at least the distal of the 1st molar.
- no mirror edges, fog or scratches should show;
- direct this view as perpendicular to the posterior teeth as possible so that the molar occlusion is displayed;

The anterior intraoral view should be centered, and the occlusal plane should not be tipped. The lips should be retracted to give a good view of the soft tissue surrounding the anterior teeth. Aim this view with the plane of occlusion exactly in the center of the frame and oriented on the horizontal. It should not be too high or too low; and this view should display the condition of the teeth and gingiva without excess saliva or debris.

The maxillary occlusal view needs a mirror to properly frame it, but the mirror edges should not show nor should there be any fog, scratches, fingerprints or debris on the mirror. Keep the bite plane parallel to the mirror horizontally, and center the middle of the palate while balancing the posterior teeth within the frame. Patient gag reflexes may limit the distal extension of the mirror, but make every effort to photograph the most distal molar in the mouth. Make

these views as perpendicular to the occlusal surfaces as possible, and they should show the arch form and alignment.

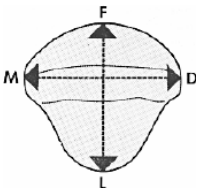
The mandibular occlusal view must observe all the precautions taken with the maxillary occlusal photograph, but the photographer has one additional challenge—keeping the tongue out of the way. Ask the patient to place the tongue behind the mirror if possible. Otherwise, they will have to hold it low in the mouth so as not to obscure the occlusal surfaces of the teeth.

The complete photographic collage can take one of many forms, but this allows a collection that doctors can place in correspondence or display to patients, parents or colleagues.

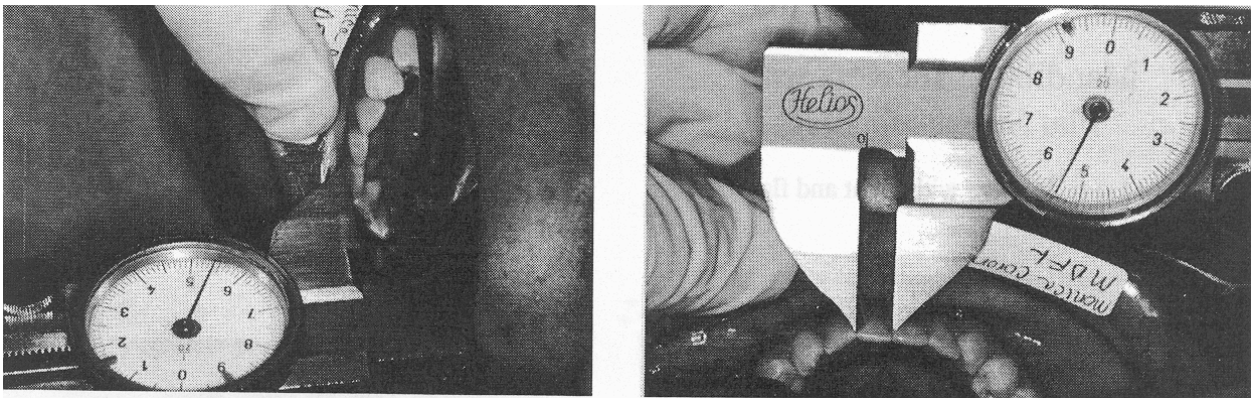
Mandibular Incisor Shape Analysis (MD/FL Analysis)

In 1972, Peck and Peck[21] suggested that the shape of the mandibular incisors had much to do with post-treatment stability and could also contribute to the overlapping and arch length discrepancy often seen in malocclusions. When the mesiodistal dimension of the mandibular incisors is too wide, correctly-aligned teeth contact at a point rather than along the proximal surface, and they have a much better opportunity of slipping the contact than when they have a surface contact. They published a tooth-size grid that provides the clinician with measurements compatible with correctly shaped mandibular incisors. Natural well-aligned mandibular incisors have a predictable relationship between their mesial-distal dimension and their facial-lingual thickness. That is, the FL dimension of well-aligned mandibular incisors exceeds the MD dimension by about .5mm. Orthodontists use a specially adapted millimeter gauge to measure both dimensions of the incisors and by referring to the grid they can determine where and how much interproximal enamel needs removal to make normally shaped incisors. When the occlusogram indicates that the relationship between maxillary and mandibular incisors is correct, then any interproximal removal of mandibular enamel will require the removal of equal amounts of maxillary incisor interproximal enamel.

A mandibular central incisor showing the mesiodistal (MD) and facial-lingual (FL) crown diameters. The MD/FL index (MD/FL X 100) is a numerical expression of the crown's shape as seen from the incisal aspect. For the incisor shown. the MD diameter approximately equals the FL diameter, yielding an MD/FL index of 100. This tooth requires MD reduction. (From Peck & Peck, Am. J. Orthod. 61: 384—401, April, 1972.)



Not all misalignments of mandibular incisors are attributable to poor MD/FL measurements, as the accompanying illustrations show, but there can be no doubt after 35 years of clinical experience with this analysis that the MD/FL has a place in the armamentarium of all orthodontists and will help them understand how many malocclusions occur and why relapses may happen after seemingly successful therapies.



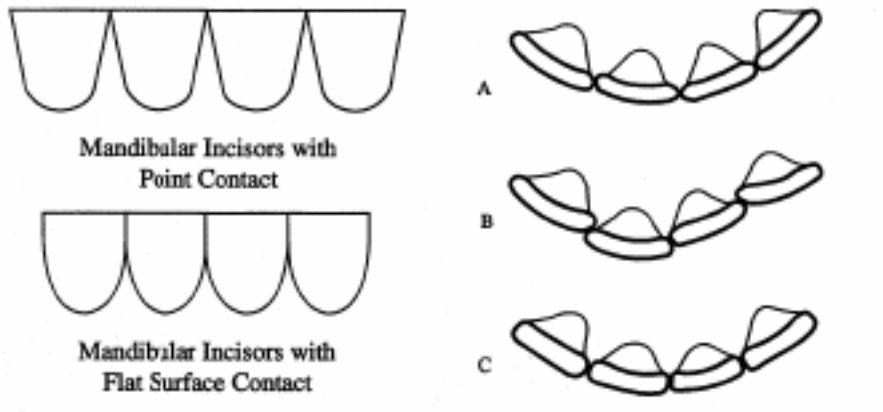
Measuring the facial-lingual and mesial-distal dimensions of the mandibular incisors.

MESIODISTAL (MD) CROWN DIMENSION

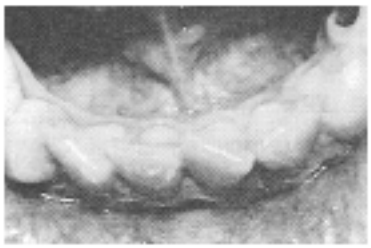
FACIOLINGUAL (FL) CROWN DIMENSION

	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4
4.7	89	91	94	96	98	100	102	104	106	109	111	113	115	117	119																		
4.8	88	90	92	94	96	98	100	102	104	106	108	110	112	115	117	119																	
4.9	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118																
5.0		86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118															
5.1			86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118														
5.2				87	88	90	92	94	96	98	100	102	104	106	108	110	112	113	115	117	119												
5.3					87	89	91	92	94	96	98	100	102	104	106	108	109	111	113	115	117	119											
5.4						87	89	91	93	94	96	98	100	102	104	106	107	109	111	113	115	117	119										
5.5							87	89	91	93	95	96	98	100	102	104	105	107	109	111	113	115	116	118									
5.6							86	88	89	91	93	95	96	98	100	102	104	105	107	109	111	112	114	116	118								
5.7								86	88	89	91	93	95	96	89	100	102	104	105	107	109	111	112	114	116	118	119						
5.8									86	88	90	91	93	95	97	98	100	102	103	105	107	109	110	112	114	116	117	119					
5.9										86	88	90	92	93	95	97	98	100	102	103	105	107	108	110	112	114	115	117	119				
6.0											87	88	90	92	93	95	97	98	100	102	103	105	107	108	110	112	113	115	117	118			
6.1												87	89	90	92	93	95	97	98	100	102	103	105	107	108	110	111	113	115	116	118		
6.2													87	89	90	92	94	95	97	98	100	102	103	105	106	108	110	111	113	115	116	118	119
6.3													86	87	89	90	92	94	95	97	98	100	102	103	105	106	108	110	111	113	114	116	117
6.4														86	88	98	91	92	94	95	97	98	100	102	103	105	106	108	109	111	112	114	116
6.5															86	88	89	91	92	94	95	97	98	100	102	103	105	106	108	109	111	112	114
6.6																86	88	89	91	92	94	95	97	98	100	102	103	105	106	108	109	111	112
6.7																	87	88	90	91	93	94	96	97	99	100	101	103	104	106	107	109	110
6.8																		87	88	90	91	93	94	96	97	99	100	101	103	104	106	107	109
6.9																		86	87	88	90	91	93	94	96	97	99	100	101	103	104	106	107
7.0																			86	87	89	90	91	93	94	96	97	99	100	101	103	104	106
7.1																				86	87	89	90	92	93	94	96	97	99	100	101	103	104
7.2																					86	88	89	90	92	93	94	96	97	99	100	101	103
7.3																						86	88	89	90	92	93	95	96	97	99	100	101
7.4																							86	88	89	91	92	93	95	96	97	99	100
7.5																								87	88	89	91	92	93	95	96	97	99

MDFL Grid.



Flattening of contact surfaces gives a wider contact area.



MDFL measurements that require polishing.

MDFL measurements that don't require polishing.

Tooth and Arch Analysis (Model Analysis)

Orthodontists typically use the models of patients' mouths to determine discrepancies in the sizes, shapes and positions of teeth as well as to study the sizes, shapes and relationships of the maxillary and mandibular arches.

Many orthodontists contend that the only accurate way of studying the relationship between maxillary and mandibular arches is to mount the models on an adjustable articulator. Nevertheless, the best articulator in the world combined with the most accurate occlusal records and models is still a poor substitute for the articulator nature has provided every patient - the human mouth and TMJ apparatus.

In the rush to collect data by using models, dentists should remember that even more valuable information can be gleaned from a careful study of the dynamic occlusion directly in the mouth. Some contend that models are necessary for making tooth-size discrepancy measurements, but these measurements can be made quite accurately in the mouth. MD/FL measurements cannot be made from the model and must be made directly in the mouth.

Orthodontists have many techniques for making models of patients' mouths, but regardless of the technique chosen, they should articulate accurately-either in an articulator or on the desk. Static, disarticulated models need to be trimmed so that the backs and sides of the models have the same plane and may be photographed or photocopied for making occlusograms.

While models provide unusually valuable information, orthodontists need to remember that the models are abstract representatives of the real occlusion and, whether articulated or not, can only approximate what the real mouth achieves.

For many decades orthodontists have used carbon papers or colored tapes of one kind or another to study the intraoral dynamic occlusion. While this works reasonably well, it still gives clinicians only a two-dimensional representation of a three-dimensional reality. Because of this, I prefer to analyze the working occlusion with Kerr Occlusal Wax. This extremely thin wax perfectly demonstrates where prematurities exist, and orthodontists may then remove them with unusual accuracy.

Section III: The Tridimensional Diagnosis and Treatment Plan

The three-dimensional diagnosis and treatment plan is nothing more than an attempt to evaluate and use all the data collected from the examination and the various analyses in the horizontal, vertical and transverse dimensions. The Visualized Treatment Objective is used to correctly position the teeth and jaws in the vertical and horizontal dimensions, while the occlusogram is used to evaluate and rearrange the teeth in the transverse dimension.

The Visualized Treatment Objective (VTO) and the Horizontal and Vertical Dimensions

The Visualized Treatment Objective derives desired positions for the incisors and molars in the vertical and horizontal dimensions. By using the VTO, clinicians can determine how much anchorage will be needed, where it will be needed and how far the incisors and molars must move horizontally and vertically to achieve ideal positions.

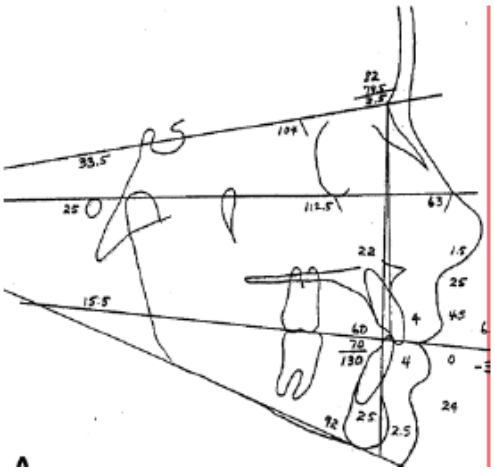
As originally developed, the VTO sought to blend the growth of a patient with the movements necessary to effect ideal tooth and jaw positions. Several articles have been written that describe step-by-step procedures for doing Visualized Treatment Objectives, and the reader can refer to these for instructions.[17,19,20,22]

Although a great deal is known about the amount and direction of average facial growth, it is much more difficult to predict whether a specific patient will adhere to those averages. Considering the recent advances of the Chaos Theory[23] which acknowledges periodicity, intermittency, randomness, unpredictability and sensitive dependence on initial conditions, orthodontists have begun to understand why dynamic VTOs based on average yearly growth increments become less accurate and valuable as treatment time lengthens. Chaotic systems such as growth are notoriously difficult to forecast and become ever more fickle as the forecast period extends. That is, a I5-month VTO has a much better chance of accurately forecasting facial growth than a 30-month projection-much like a l2-hour weather forecast remains more reliable than a five-day forecast.

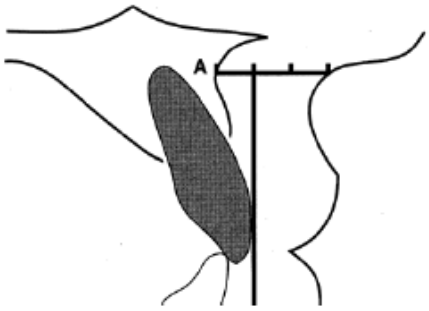
Since most of my treatments extend beyond 12 or 15 months, I seldom use dynamic VTOs and rely on static ones that simply position the teeth in ideal positions vis á vis the initial cephalometric tracing. This helps me set goals for the movement of teeth and jaws, and I start treatment by trying to achieve these movements quickly. The accompanying illustration shows how the incisors and molars are repositioned to approximate an ideal arrangement of teeth in a static VTO.

The Static Visualized Treatment Objective

1. Begin the VTO by establishing a new occlusal plane on the original tracing by extending the line between the occlusal surfaces of the maxillary and mandibular molars to a point 3 - 5mm below the lip embrasure This point is determined through the clinical examination and is somewhat subjective. It depends on how much the maxillary incisors and/or gingival display at rest, when smiling and how much the clinician feels the patient may display at middle-age. Since aging causes soft tissues to droop, too much incisor intrusion at an early age may result in no display of teeth later on. Earlier researchers suggested placing the maxillary incisors at 3mm below the lip embrasure, but that may not be a realistic goal when one considers the effect of aging. Five to six millimeters below the embrasure may offer a more esthetic future for adolescents. Unfortunately, this decision must remain subjective until we have more data. Nevertheless, the clinical impression will give clinicians the best clue how much incisor and gingival display is acceptable in an individual patient.
2. After drawing the new occlusal plane, decide where the maxillary incisor will be placed in the horizontal plane. One of three techniques or a combination of them offers the best guide for this decision. Holdaway first suggested using the maxillary incisor and soft-tissue rather than the mandibular incisor as a guide to the horizontal position of the dentition. Creekmore and Alvarez have recently expanded on this idea and offer some objective measurements easily implemented in VTOs.
3. Creekmore suggests placing the maxillary incisor 4 - 5mm ahead of the NA cephalometric line and subsequently placing the mandibular incisor on or near the NA line and one millimeter above the occlusal plane.
4. Alvarez suggests placing the maxillary incisor on or within one millimeter of the A Line, which is determined by dividing the distance between soft-tissue A point and hard-tissue A point into thirds. A Line will be a perpendicular line dropped from True Horizontal through the one-third point nearest hard - tissue A.



Note the NA line bisects the mandibular incisor and the maxillary incisor lies 4mm anterior to it.



Note the perpendicular line (A line) dropped from True Horizontal and how the maxillary incisor touches it.

5. The Creekmore and Alvarez techniques have much congruence, and clinicians can use them to confirm one another. At any rate, the maxillary incisor is positioned vertically and horizontally on the new occlusal plane, and the mandibular incisor is then positioned 1mm above the occlusal plane and against the lingual surface of the maxillary incisor using the Creekmore or Alvarez method or a combination of them.
6. Next decide on the molars' positions for ideal occlusion. If the molars need mesial movement, then extractions may be necessary. If the molars need distal movement, then extractions may or may not be needed, but adequate anchorage must be developed to accomplish this change
7. By superimposing the completed VTO and the original cephalometric tracing, clinicians can determine how much excess space exists or how much space needs to be creatied to solve the malocclusion.

Note the repositioning of maxillary and mandibular incisors. The maxillary incisor has intruded but has not moved horizontally. The mandibular incisor has advanced 3mm and slightly extruded to allow proper overbite and overjet. The molars did not need to relocate since they were in Class I at the beginning.

8. A modified Steiner Box can help keep these measurements and plans organized.

The patient's occlusograms indicated an arch length discrepancy measurement of –6mm; however, the VTO shows a need to advance the mandibular incisors 3mm on each side for a total of 6mm. These numbers cancel one another as do the compensations for the Curve of Spee and the need to reduce enamel interproximally. This modified Steiner Box differs from the original in its consideration of maxillary arch features, as well as those of the mandibular arch. This patient had no maxillary arch length problems, nor did the maxillary incisors need any horizontal changes.

	Max	Man
Arch Length Discrepancy		-6mm
Arch Development		
Relocation Incisor		+6mm
Mesial Molar Movement		
Distal Molar Movement		
Curve of Spee		-1mm
Interproximal Reduction		+1mm
Extractions		
Relocation of Max. 3s		
Total Net		0

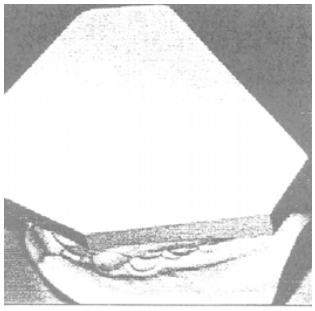
The Occlusogram and the Transverse Dimension

Fewer than 1% of orthodontists now use occlusograms as aids in their diagnoses, but that does not lessen their value at all. On the contrary, no diagnostic technique offers orthodontic clinicians more useful information about malocclusions than do occlusograms. They are particularly useful for evaluating and planning in the transverse dimension. The occlusogram, popularized by Burstone,[24,25] is a technique that arranges teeth in ideal arch forms in two dimensions on a piece of tracing paper and thus allows a transverse evaluation of the occlusion. The occlusogram offers orthodontists several advantages they cannot otherwise obtain and allows them to:

- predetermine arch forms for the entire treatment;
- establish patterns for arch wires that are easily taught and learned by auxiliaries and used throughout treatment;
- make accurate arch-length discrepancy measurements;
- determine arch-width discrepancies;
- discover tooth-size discrepancies;
- do treatment simulations;
- perform dental setups without plaster models.

I include a simplified and less costly step-by-step method of constructing them using Brader arch forms.[26] This is not necessarily the most accurate way of making them, but it is quick, easily teachable, reasonably accurate and offers consistency in their construction and coordination between the maxillary and mandibular arches.

1. Trim the study models so that the backs and posterior angles of the models are cut together and in the same planes.

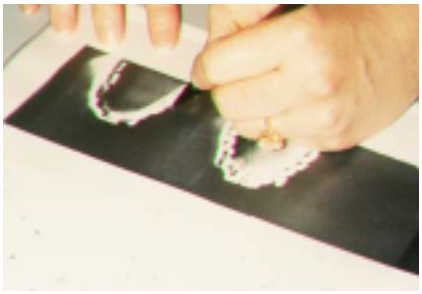


2. Mark the retromolar pads of the upper and lower models with an R and an L to identify the left and right sides of the models. This eliminates confusion about occluding the tracings.

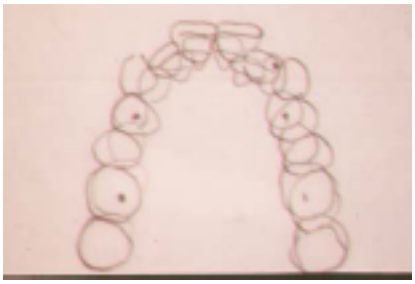
3. Occlude the teeth tightly together with the occlusal registration between them. Select the most prominent contact between the posterior teeth on both sides and mark through the occlusal contact with a sharp pencil leaving a black pencil point showing on the occlusal surfaces of both maxillary and mandibular teeth on both sides. These will be the occlusal references used to occlude the tracings.

4. Make a 1:1 reproduction of the occlusal surfaces of the models with a photocopier.

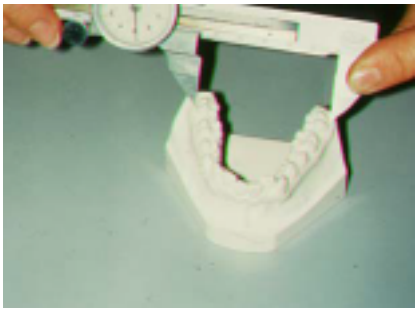
5. Place a sheet of cephalometric tracing paper over each 1:1 reproduction of the occlusal surfaces of the models and trace the teeth including the gingival margins and all the necessary anatomy.



6. Align the maxillary arch to the mandibular arch by using the occlusal pencil marks you made on the teeth and remember to align the maxillary right side to the mandibular right side. After aligning the right side of the mandibular tracing with the right side of the maxillary tracing with the help of the occlusal pencil dots, view the occlusion in two planes of space and reconsider the anterior, posterior and lateral overjets. You may also reappraise the widths of the maxillary and mandibular arches and the points of occlusal contacts, rotations, etc.

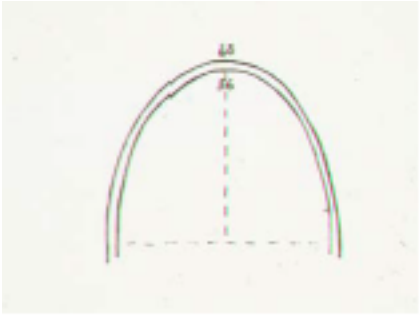


7. Measure the widths of the mandibular second permanent molars either on the models or the photocopies. Measure this width at the most buccogingival prominences on the second permanent molars and then select a Brader arch form that most nearly conforms in size. For instance, if the width is 54 mm, select a 56 Brader for the mandibular arch and a 60 Brader form for the maxillary arch. If the second permanent molars are unerupted, measure the mandibular first permanent molar width in the same manner at the molars' most prominent buccogingival margins and add 4 mm to reach the correct Brader arch form.

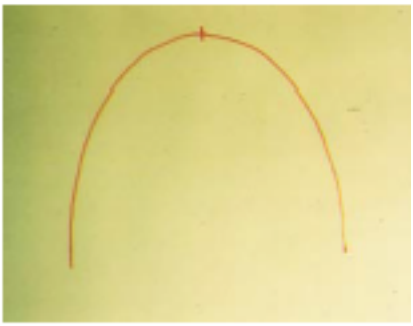


8. When first learning to use Brader arch occlusograms, use the solitary arch forms and trace the selected arch form onto a piece of cephalometric tracing paper. Mark a midline on the traced mandibular arch form. Beginning with the mandibular central incisors, lay the arch form over each tooth of the reproduction and trace that tooth in an ideal position along the arc of the Brader form. Continue tracing the teeth until all of the teeth through the first permanent molars are arranged in a symmetrical and smooth arch that conforms to the Brader form.

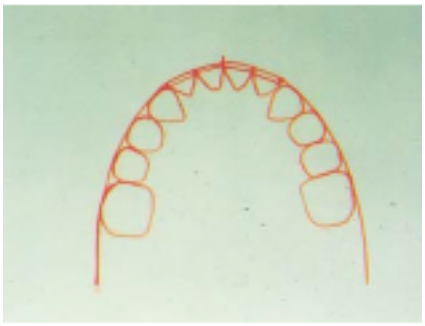
Selection of the maxillary and mandibular Brader arch forms



Mandibular arch with midline selected.



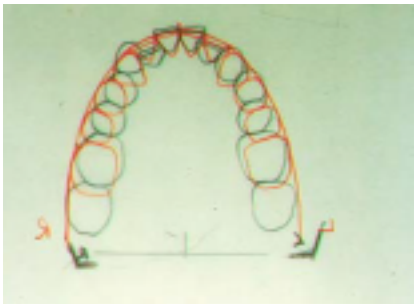
Mandibular arch with teeth rearranged in an ideal Brader arch form.



9. Repeat step number 8 for the maxillary arch

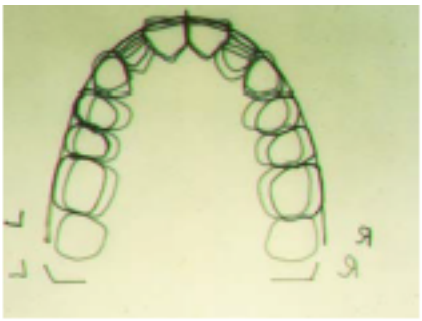
10. Position the mandibular Brader occlusogram over the lower 1:1 reproduction by using the most normally positioned incisors of the reproduction as reference teeth. Determine the arch-length discrepancy between the malocclusion and ideal Brader occlusogram by measuring the difference in length between the two arches. The illustrated occlusogram displays approximately 3 mm of discrepancy between the ideal occlusogram and the original malocclusion.

Mandibular arch superimposed on the 1:1 tracing of the malocclusion, which shows 1mm of discrepancy on the right side and 2mm on the left.

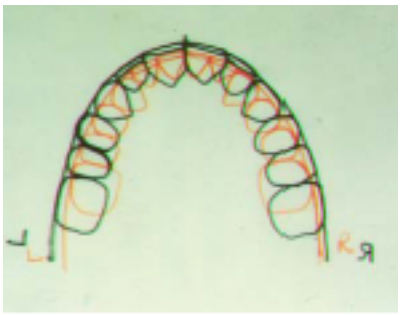


11. Position the maxillary Brader occlusogram over the upper 1: 1 reproduction of the maxillary model by using the best positioned incisors as a reference. Notice the difference in widths and any tendencies for a posterior cross bite. Note the absence of arch-length discrepancy between the ideal occlusogram and the malocclusion, but notice the width needs.

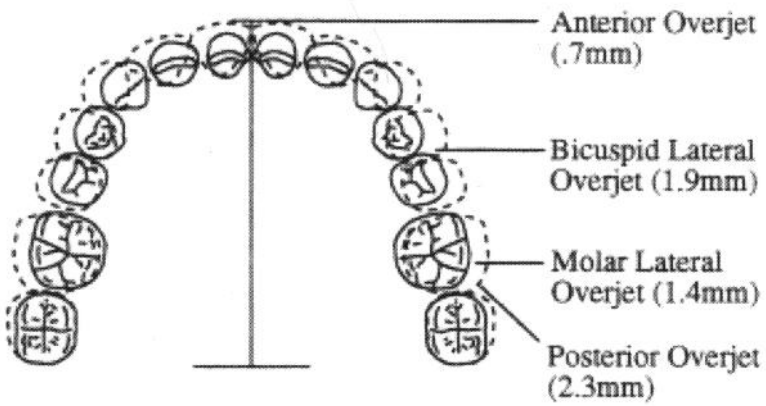
Maxillary ideal arch superimposed on the 1:1 tracing of the malocclusion showing no discrepancy but considerable width needs.



12. Superimpose the maxillary and mandibular ideal occlusograms by aligning the midlines and allowing 1mm overjet in the anterior. The maxillary posterior teeth should fit between those of the mandible, and there should be a posterior overjet of the maxillary molars. If the maxillary lateral incisors have acceptable widths, they should approach the middle of the mandibular canines.

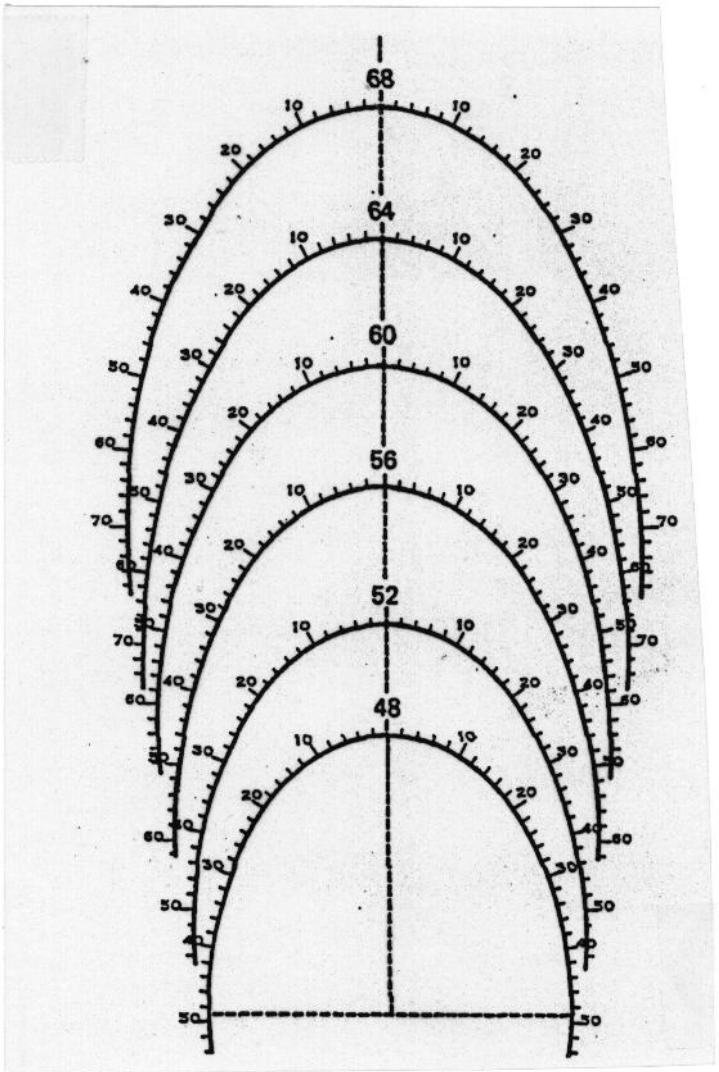


Occlusogram of an untreated Class I occlusion with ideal anterior, posterior and lateral overjet.



Typical ideal normal Class I occlusogram.

A 1:1 set of Brader arch forms, which clinicians can use for occlusograms or as arch forms to make indirect arch wires.



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