

CEPHALOMETRIC GROWTH ANALYSIS
Method and clinical application



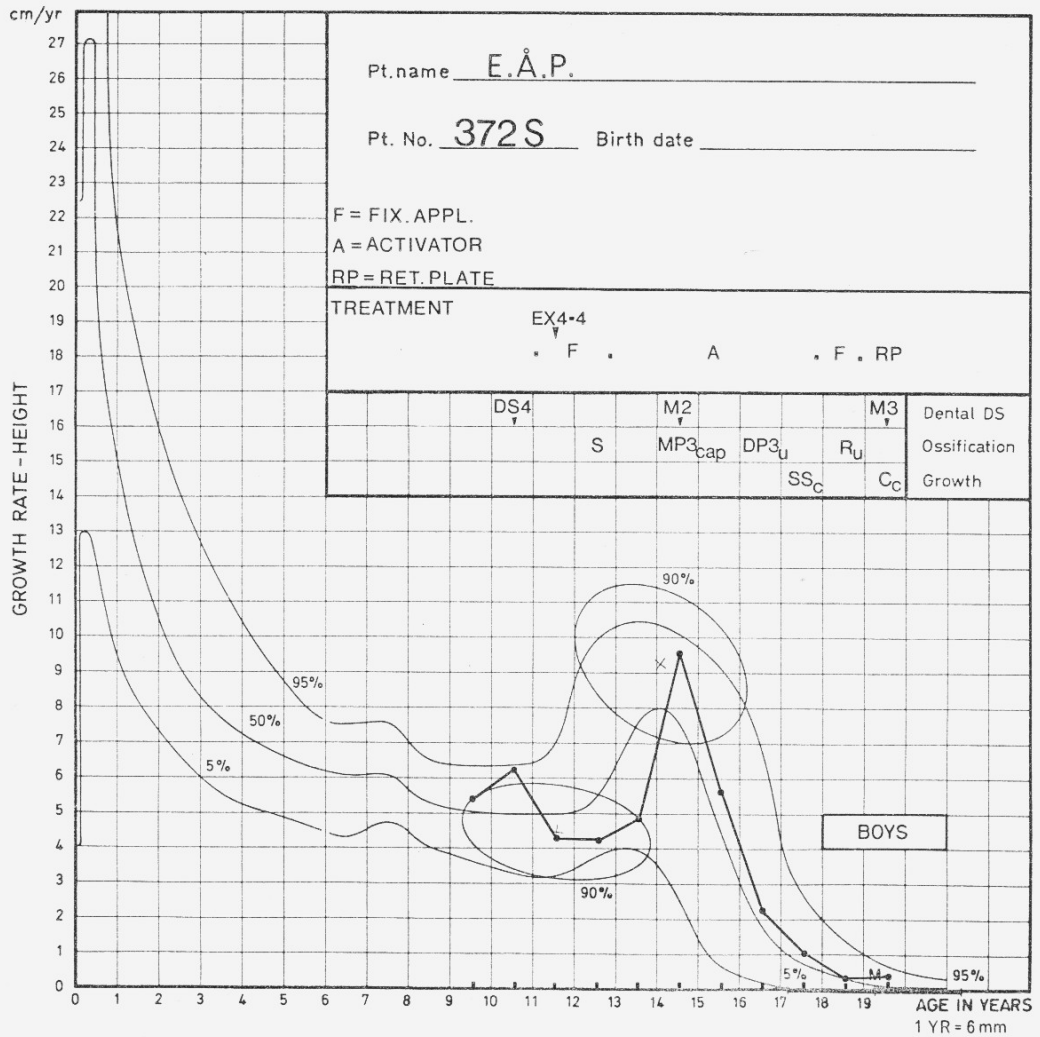
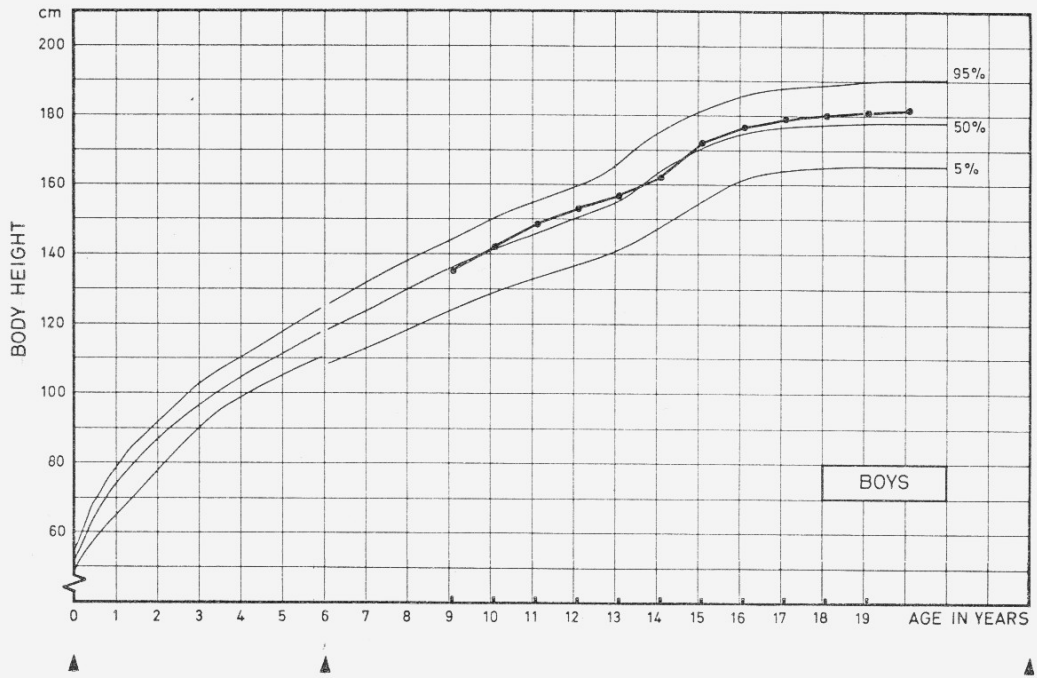
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PROGRAMME

METHOD OF ANALYSIS

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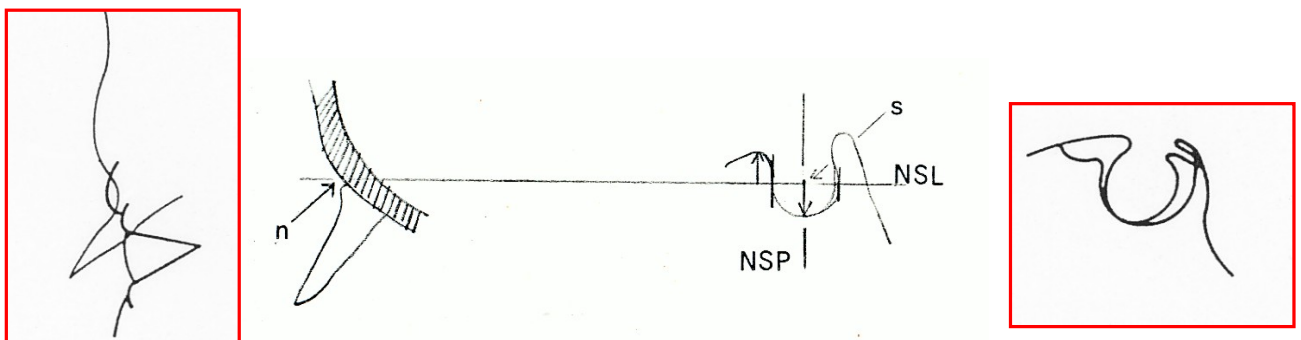
SUPERIMPOSITION OF PROFILE RADIOGRAPHS BY THE STRUCTURAL METHOD

The nasion-sella line (NSL) can only be used in growth analysis after adjustments have been made. In connection with apposition in the glabella region, the nasion point (n) moves forward throughout the entire growth period and during this may be displaced upward or downward. The excentric remodelling of the sella turcica during growth has the result that the position of the midpoint (s) of the sella turcica is displaced backward and possibly upward or downward.

In the following procedure, an attempt has been made to reduce these sources of error by transferring the NSL line, as registered on the first film in the series, to the subsequent films by use of the structures defined in the anterior cranial fossa and certain structures in the braincase.

Practical procedure

The practical procedure consists in placing a sheet of cellophane with printed cross lines on the first film of a series, passing through the nasion and with the centre of the cross lines at the sella point, or alternatively, to draw cross lines with a pencil directly on the first film. The subsequent films of the series are then superimposed according to the structures on the first film, as described below and as illustrated on page 4, and then the cross lines from the first film are transferred to the subsequent films. Displacement of Nasion is marked by an arrow and projected onto the transferred NSL. The Sella Point is transferred from the first film.



Definition of Nasion and Sella on the first film

Superimposition: See Page 4

Sagittally

Films from two age stages are orientated in the sagittal direction by

(1) superimposition on the contour of the anterior wall of the sella turcica which does not show greater remodelling and likewise

(2) from the end of the juvenile period on the anterior contour of the median cranial fossa.

The length of the sella turcica increases by resorption at its posterior wall while the contour of the dorsum sellae moves backward with mineralization of covering cartilage. Increase in height of the sella may take place by apposition at the tuberculum sellae and by resorption at the floor.

Vertically

When transferring the sella point in the vertical direction the mean intersection point of the lower contours of the anterior clinoid processes and the contour of the anterior wall of the sella is made to coincide (cf. Walker). Towards the end of the juvenile period the sella orientation is further facilitated by the observation that

(6) the distance from the sella point to a defined contour at the inner surface of the frontal bone in the bregma region often becomes stabilized. In the anterior part of the cranial base the films are orientated vertically by

(3) coincidence of the contour of the cribriform plate and possibly also by the

(4) contour of the median border of the cerebral surface of the orbital roof. Further guidance is provided by

(5) irregularities in the inner contour of the frontal bone.

Logical sequence of growth changes

Note that

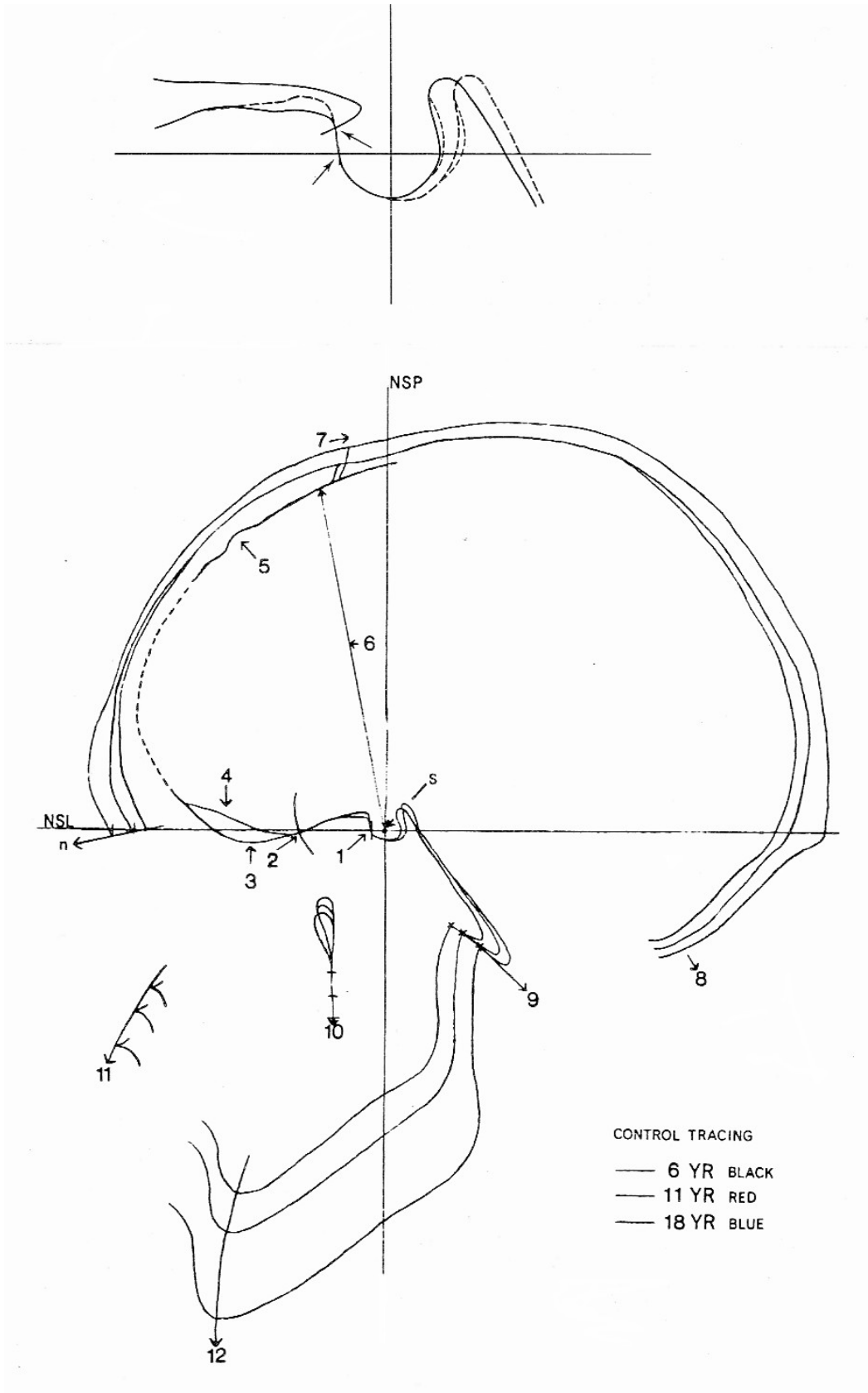
(7) the frontoparietal suture lies more posteriorly on subsequent films but never anteriorly,

(8) and the outer contour of the occipital bone is lowered. By superimposition of three or more films it is noted that the points (9) articulare, (10) pterygomaxillare, (11) anterior nasal spine and (12) tip of the chin have a natural logical placing on the different stages.

Orthodontic treatment may influence the position of these points, 9 to 12.

Control tracing

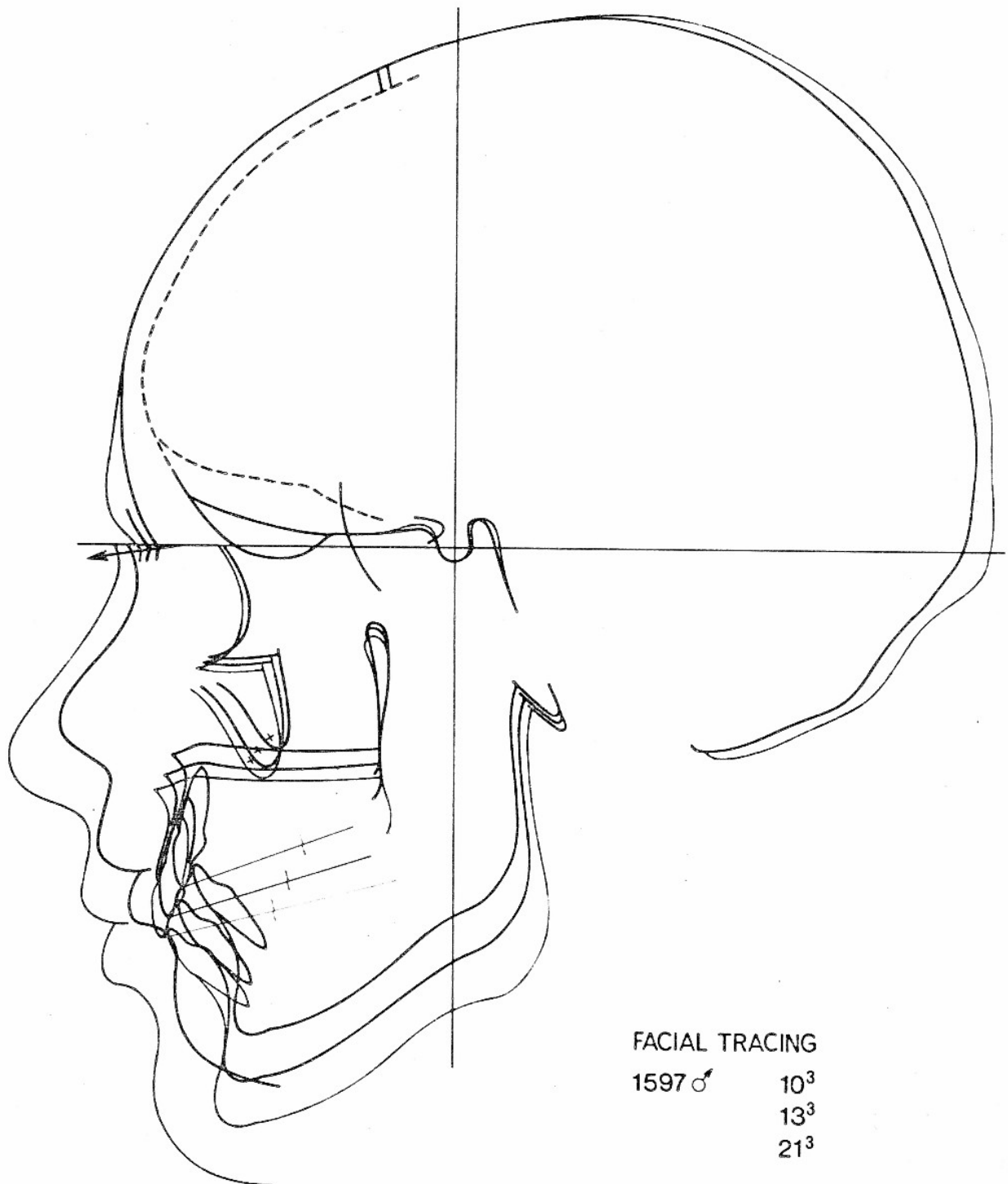
The first step in the cephalometric growth analysis is to control the orientation by means of a tracing. All stages are drawn on one paper with orientation to the crosslines as illustrated below.



GROWTH OF THE FACE

Facial tracing

A facial growth tracing is now made. As the orientation has been checked, only the cross lines need to be drawn as reference lines. Teeth may be drawn on different stages but the soft tissue profile and the outline of the brain case only on the first and last stage, as illustrated below.



GROWTH COMPONENTS IN JAW RELATIONSHIP

Vertical Jaw Relation

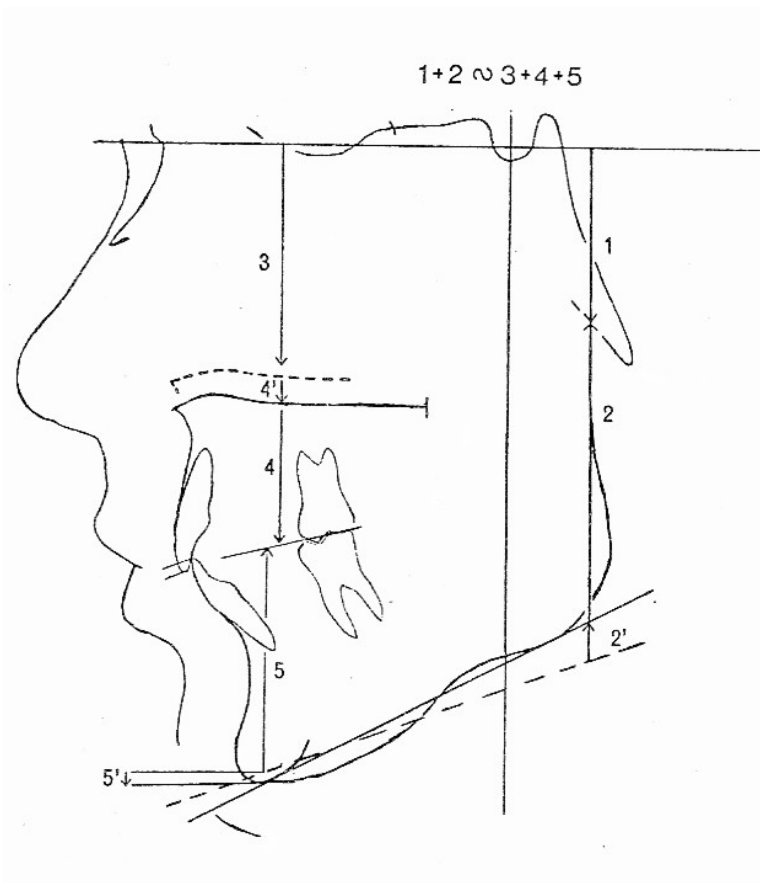
Components in facial growth contributing to an increase in the posterior face height relative to the anterior face height (forward growth rotation of the face). Components contributing to a backward rotation of the face are reverse.

Posterior face height

1. mandibular Lowering of the mandibular joint in the cranial base (increase in distance from NSL to ar)
 - sutural lowering of the temporal bone
 - apposition at the fossa
2. Growth in height of the ramus by condylar growth
(2' denotes resorption under the gonial angle)

Anterior face height

3. Little sutural lowering of the maxilla
4. Little appositional growth in height of the maxillary alveolar process
(4' denotes resorptive lowering of the nasal floor)
5. Little appositional growth in height of the mandibular alveolar process
(5' denotes apposition under the symphysis)



Sagittal Jaw Relation

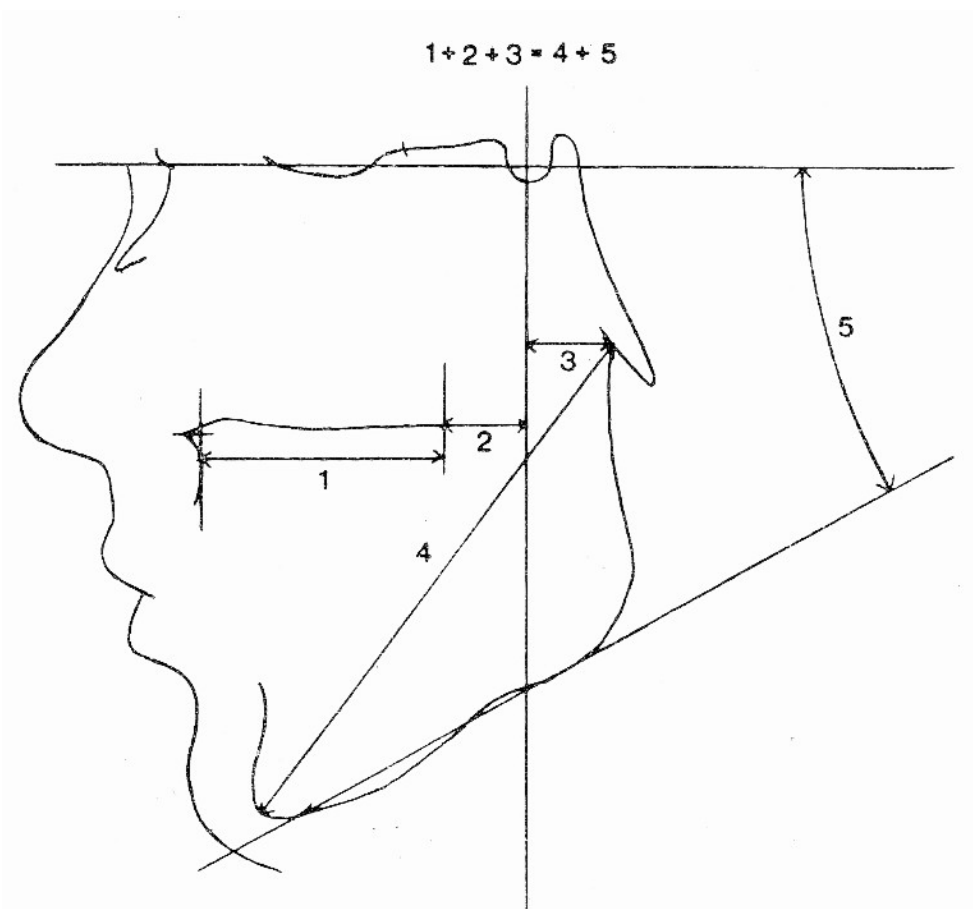
Components in facial growth contributing to an extrusion of the mandible relative to the maxilla. Components contributing to a relative protrusion of the maxilla are reverse.

Upper face

1. Small sutural growth in length of the maxilla (small increase in distance ss-pn)
2. Backward displacement of the maxilla as a whole (decrease in distance pn-NSP)

Lower face

3. Small backward displacement of the mandibular joint in the cranial base (small increase in distance NSP-ar)
4. Growth in length of the mandible at the condyle (increase in distance pgn-ar)
5. Forward rotation of the mandible (decrease in the angle NSL/ML, but dependent on remodelling of the lower border and centre of rotation)



METHOD FOR CLINICAL EVALUATION OF GROWTH CHANGES IN SAGITTAL JAW RELATIONSHIP

Film A

Place a paper with crosslines on film A.

Trace the anterior nasal spine outline and mark its horizontal position.

Draw a line through reference point subspinale (ss) perpendicular to NSL.

Trace the anterior and lower contour of the chin.

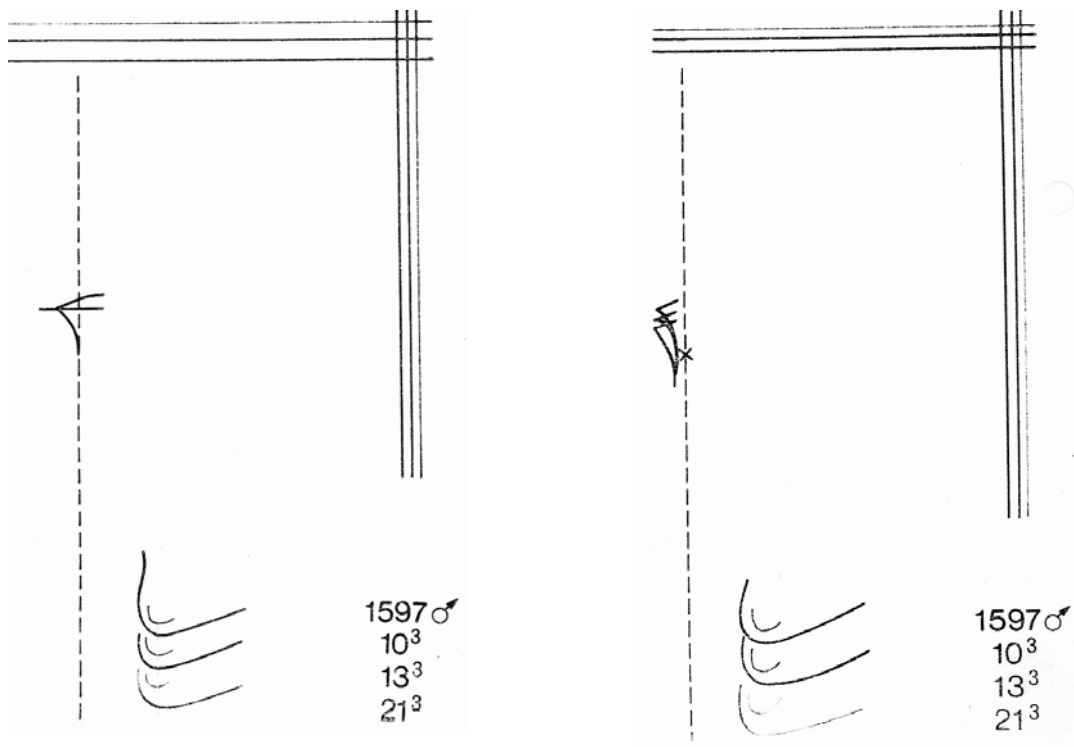
Films B and C:

Move the tracing paper to films B and C and superimpose on the anterior nasal spine and subspinale, keeping the NSL parallel

Trace the anterior and lower contour of the chin

Analysis:

1. Change in sagittal jaw relationship is indicated by the sagittal difference in the position of the chin.
2. Growth in height of the alveolar processes in both jaws is indicated by the lowering of the chin (increase in lower face height).
3. Growth in length of the maxilla is indicated by the posterior shift of NSP, which is the sum of growth against the palatine bone and a forward or backward positional change of the total maxilla.
4. Growth in height of the upper face is indicated by the upward shift of NSL, which is sutural growth added to the resorptive lowering at the nasal floor.



TRACING OF MAXILLARY GROWTH WITH THE USE OF IMPLANTS

Illustrated on page 11

1. NSL orientation

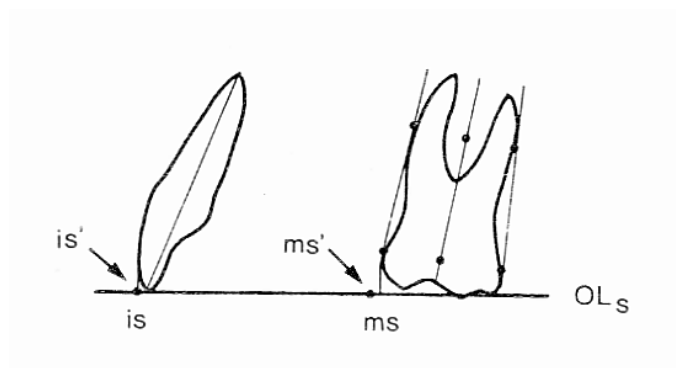
Make a detailed tracing of the maxilla from three stages using the structural method as reference. Draw the implant lines on the three stages. Trace the axis of the central incisor and of the first molar and draw the occlusal line OLs. Mark ar and ba on the three stages.

2. Registration on lateral implants

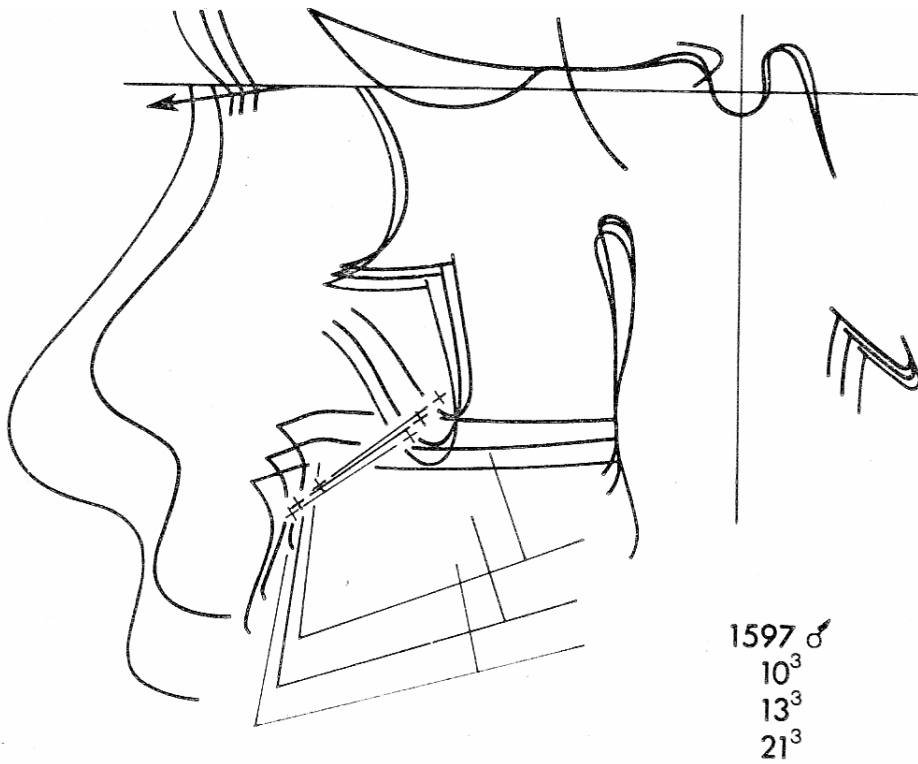
Make a tracing of the three stages using the implant line as reference and superimpose on the lateral implant. The anterior contour of the zygomatic process coincides well on the three stages. The implant line is shortened anteriorly. Change in inclination of NSL on three stages indicates the degree and the direction of the rotation of the maxilla.

3. Registration on anterior implants

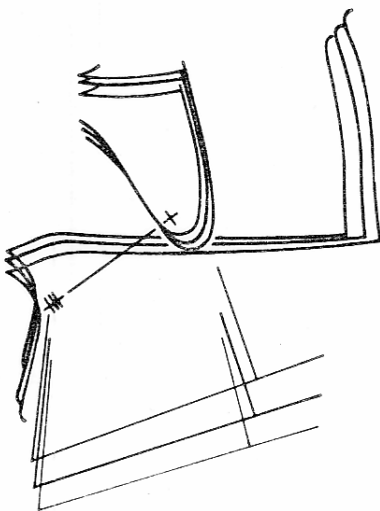
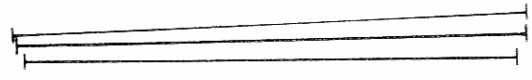
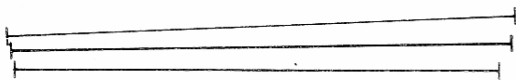
Make a new tracing of the maxilla again using the implant line as reference but now superimpose on the anterior implant. The anterior contour of the zygomatic process is no longer coinciding, but the inclination at the three stages is unchanged. The implant line is shortened posteriorly. The degree and the direction of the maxillary rotation is unchanged.



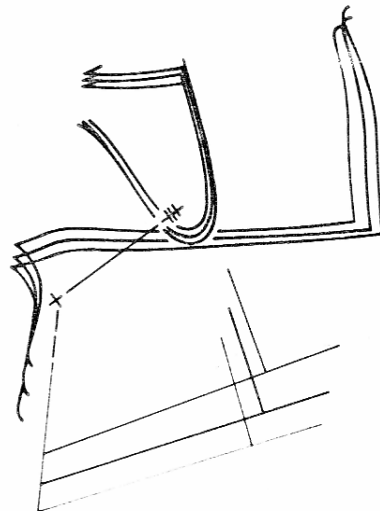
TRACING OF MAXILLARY GROWTH WITH THE USE OF IMPLANTS



NSL ORIENTATION



REGISTRATION ON LATERAL IMPLANTS



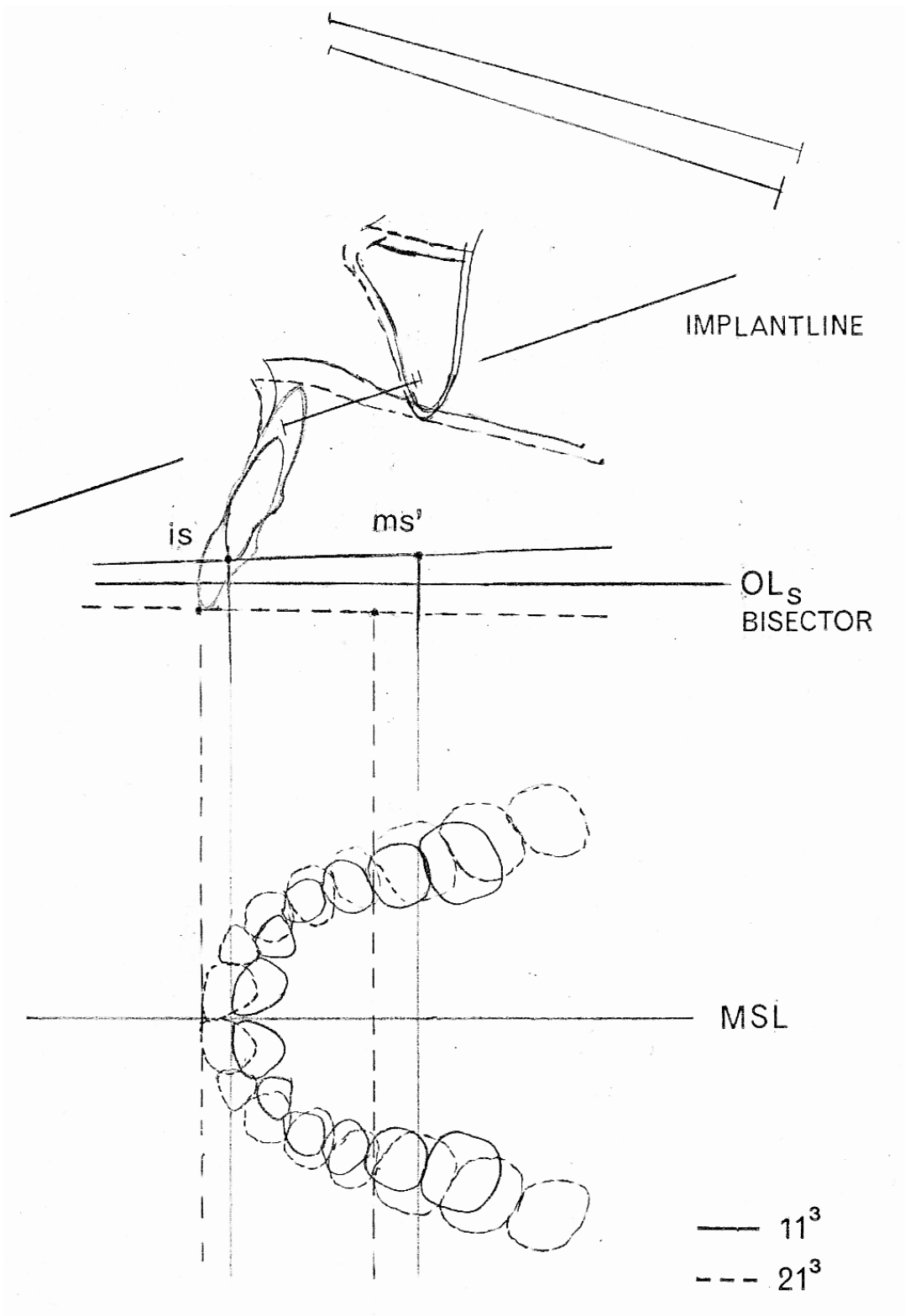
REGISTRATION ON ANTERIOR IMPLANTS

TRACING OF UPPER DENTAL ARCH DEVELOPMENT WITH THE USE OF IMPLANTS

Illustrated on page 13

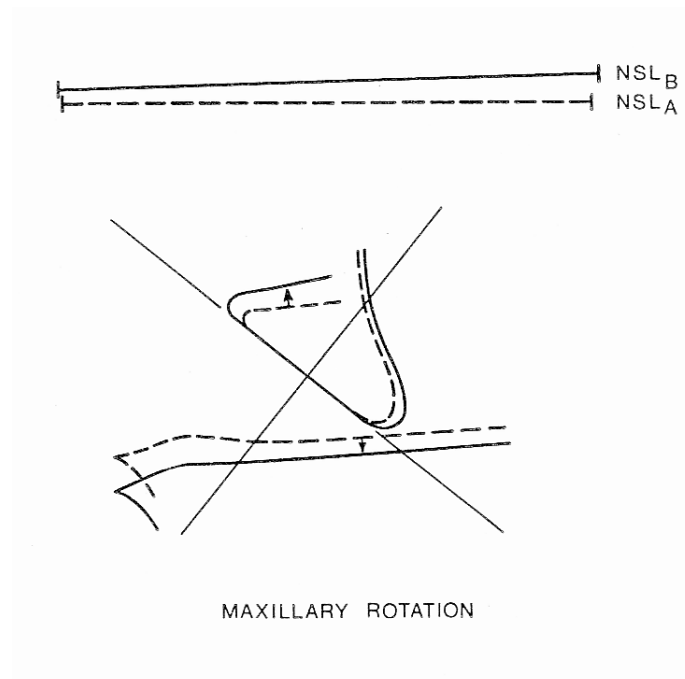
1. Trace the outline of the maxilla and the central incisor on two stages using the implant line as reference and register on the anterior implant. Draw NSL on the two stages.
2. Draw the occlusal line OL_s on both stages and construct a bisected line, $OL_s - \text{Bisector}$.
3. Mark on the occlusal line in each stage \underline{is}' , and then plot \underline{ms}' corresponding to the dental arch length determined from the X-rays of the dental casts (i.e. without magnification, page 9).
4. Drop from \underline{is}' and \underline{ms}' on both stages lines perpendicular to $OL_s - \text{Bisector}$.
5. Draw a mid-sagittal line of the dental arches, MSL, parallel to the $OL_s - \text{Bisector}$ line.
6. Trace the teeth from the X-rays of the dental casts on the two stages.

TRACING OF UPPER DENTAL ARCH DEVELOPMENT WITH THE USE OF IMPLANTS



METHOD OF MAXILLARY SUPERIMPOSITION BY NATURAL REFERENCE STRUCTURES

1. To determine rotation of the maxilla two profile radiographs are superimposed on a constructed line drawn along the anterior contour of the zygomatic process. Change in the inclination of NSL indicates the degree and the direction of the rotation of the maxilla.
2. To adjust for vertical growth the two radiographs are placed so that the amount of apposition at the floor of the orbit and the amount of resorption at the nasal floor is estimated to be equal. A perpendicular line drawn on both radiographs serves as a reference.



When making a tracing of the upper dental arch development based on this method of structural maxillary superimpOs i tion trace the outline of the maxilla and the central incisor on two stages using the cross-lines as orientation and proceed as described on page 12.

METHOD OF MANDIBULAR SUPERIMPOSITION BY NATURAL REFERENCE STRUCTURES

Natural reference structures in the mandible

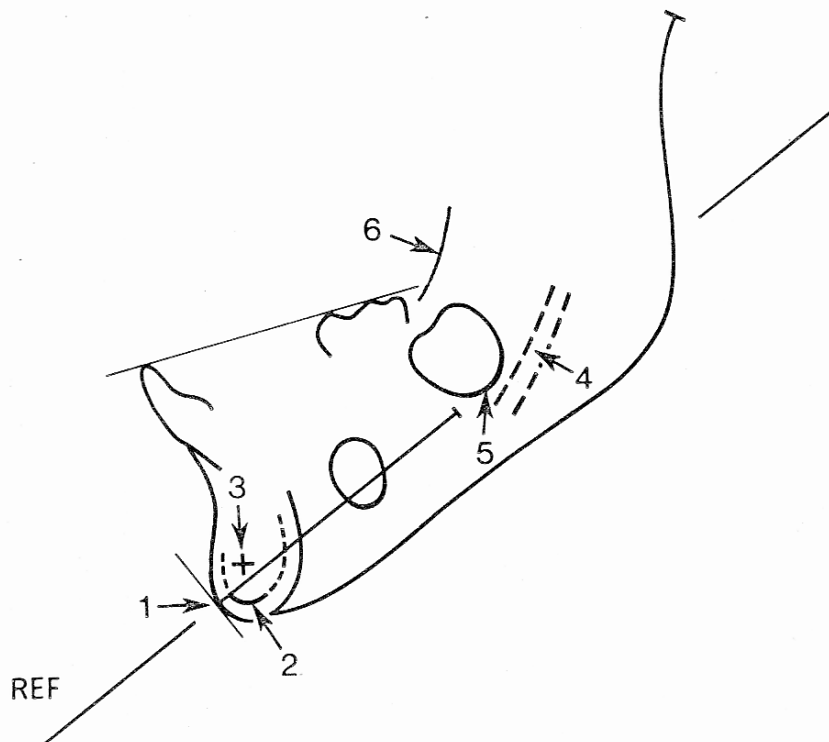
1. Anterior contour of the chin.
2. Inner contour of cortical plate at the lower border of the symphysis
3. Trabecular structures in the lower part of the symphysis.
4. Contour of the mandibular canal.
5. Lower contour of a molar eventually of a premolar germ before root development.

Logical sequence when orientating

- 5a When root development has begun the lower contour of a tooth germ continuously moves upwards in the alveolar process, but is normally not lowered below its original level.
6. Notice that the anterior contour of ramus lies more posteriorly on subsequent films, but never anteriorly.

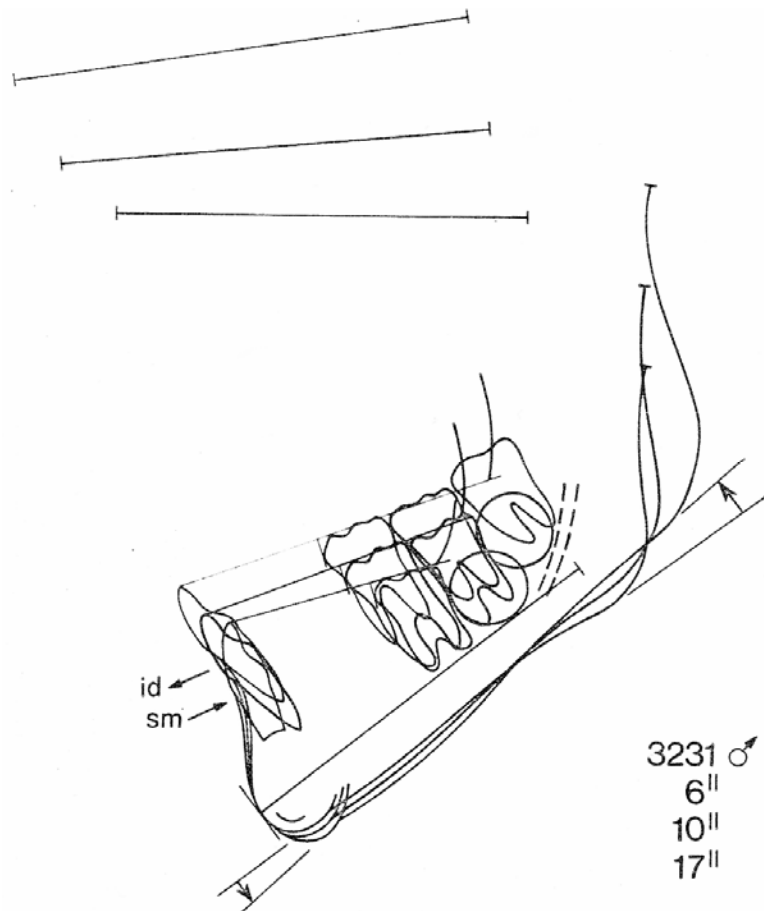
Reference line

1. Construct by pencil a reference line on film A from the anterior contour of the chin to the lower contour of a molar germ or the contour of the mandibular canal as on the illustration.
2. Superimpose the subsequent films after natural reference structures and transfer the constructed reference line by pencil to these films.



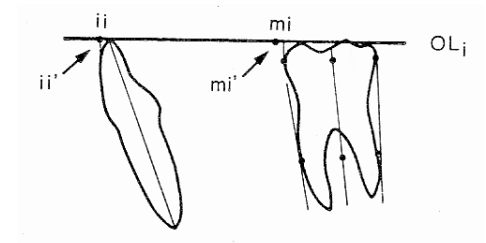
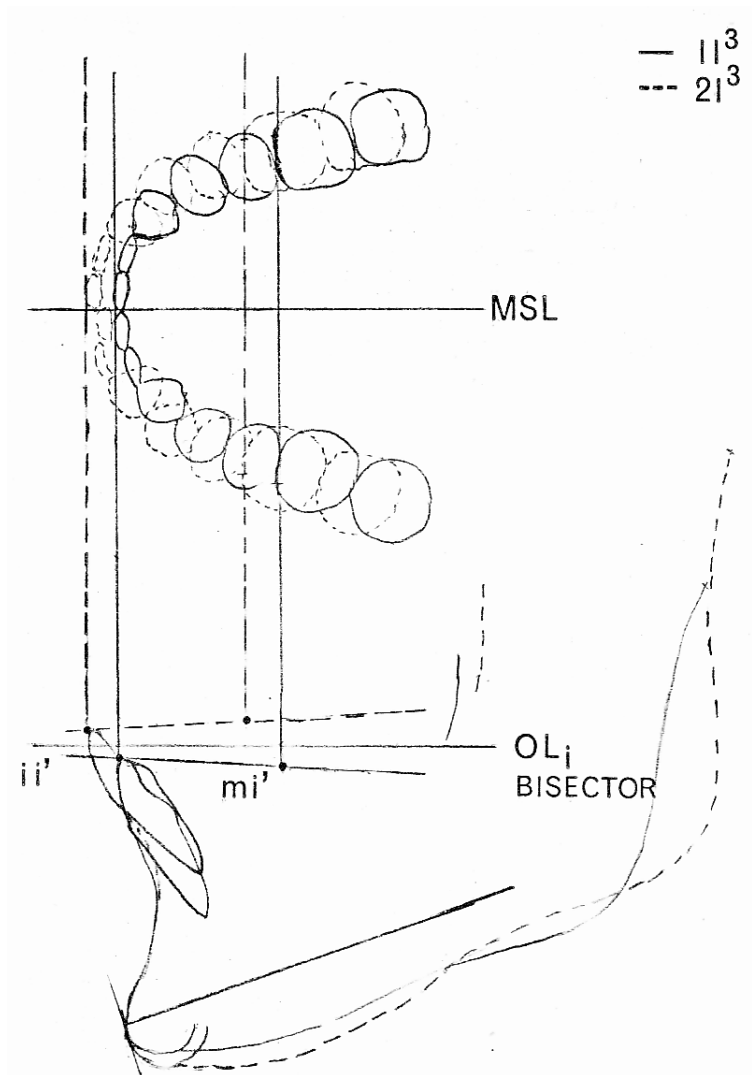
TRACING OF MANDIBULAR GROWTH BY NATURAL REFERENCE STRUCTURES

1. Make an outline drawing of the mandible on film A including the constructed mandibular reference line. Transfer the tracing paper to the subsequent films B and C using the mandibular reference line for orientation and draw the mandibular outlines from these stages.
2. Trace the anterior margin of the ramus (these contours must show a logical relationship on the three films).
3. Draw the NSL lines from the three stages.
4. Draw a line indicating the direction of condylar growth using the point articulare.
5. Draw the occlusal line (OLi) for the three stages (through the tip of the lower incisor and the distal cusp of the lower first molar) and mark the points ii and mi :
 - a. Incision inferius (ii) is marked on the occlusal line at the most anterior contour of the central incisors.
 - b. Molare inferius (mi) is marked at the anterior surface of the first molar. This point is determined by measurement from a cast or from a radiography of the cast enlarged by 5% to adjust for enlargement of the profile head film.
6. Draw the outline of the incisor and the molar using a template.



TRACING OF LOWER DENTAL ARCH DEVELOPMENT BY NATURAL REFERENCE STRUCTURES

1. Trace the outlines of the mandible and the incisors on two stages, when superimposing at the constructed reference line.
2. Draw the occlusal line (OL_i) on both stages and construct a bisected line OL_i Bisector.
3. Mark on the occlusal line in each stage ii' and then plot mi' corresponding to the dental arch length detennined from the X-rays of the dental casts (ie. without magnification).
4. Draw from ii' and mi' on each stage lines perpendicular to the OL_i Bisector line.
5. Draw a mid-sagittal line of the dental arches MSL parallel to the OL_i Bisector line.
6. Trace the teeth from the X-rays of the dental casts.



APPENDIX I - DEVELOPMENT OF OCCLUSION

Sagittal Occlusion

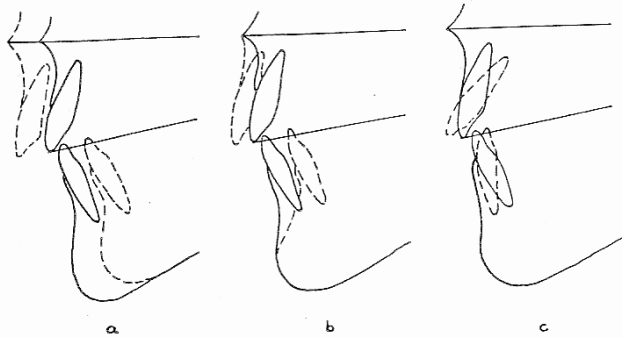
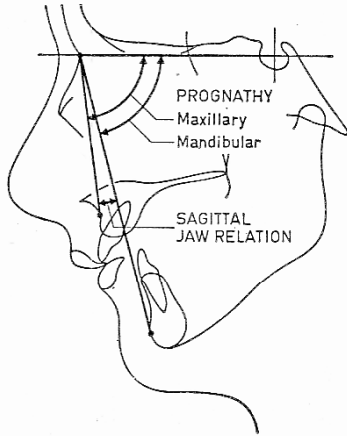


Fig. 9.—The three main causes of maxillary overjet (horizontal overbite) shown by the broken lines:
 a, A relative difference in basal prognathism.
 b, A relative difference in alveolar prognathism.
 c, Inclination of the incisors. (From Björk, 1947.)

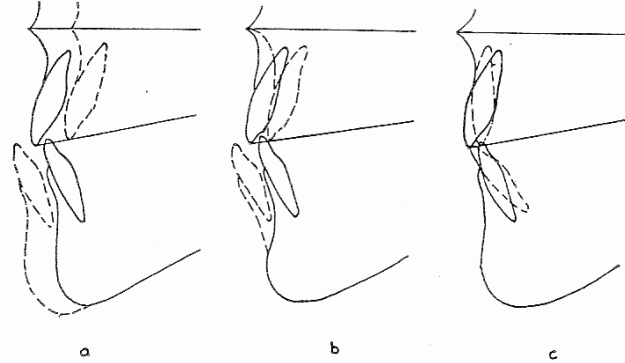


Fig. 11.—The three main causes of mandibular overjet (horizontal overbite) shown by the broken lines:
 a, A relative difference in basal prognathism.
 b, A relative difference in alveolar prognathism.
 c, Inclination of the incisors. (From Björk, 1947.)

Vertical Occlusion

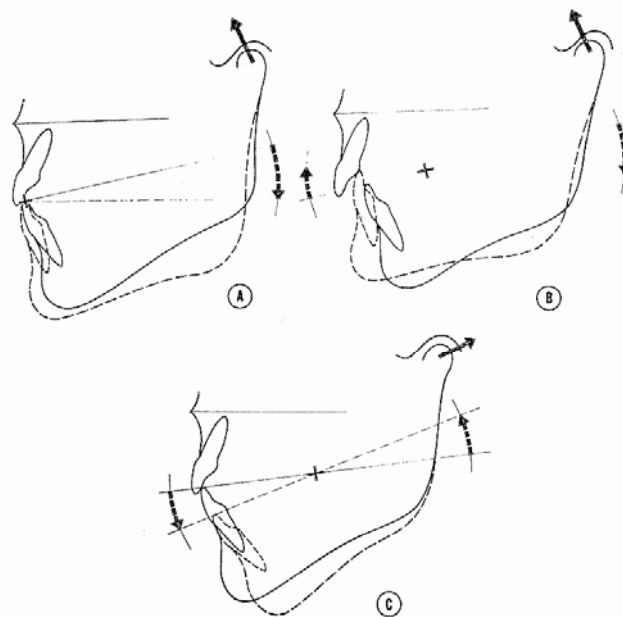
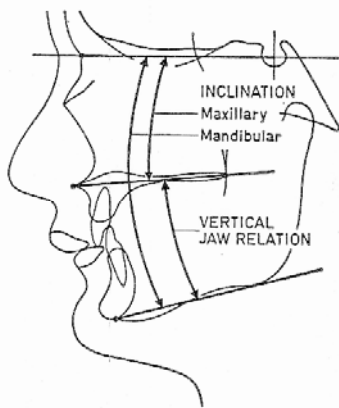
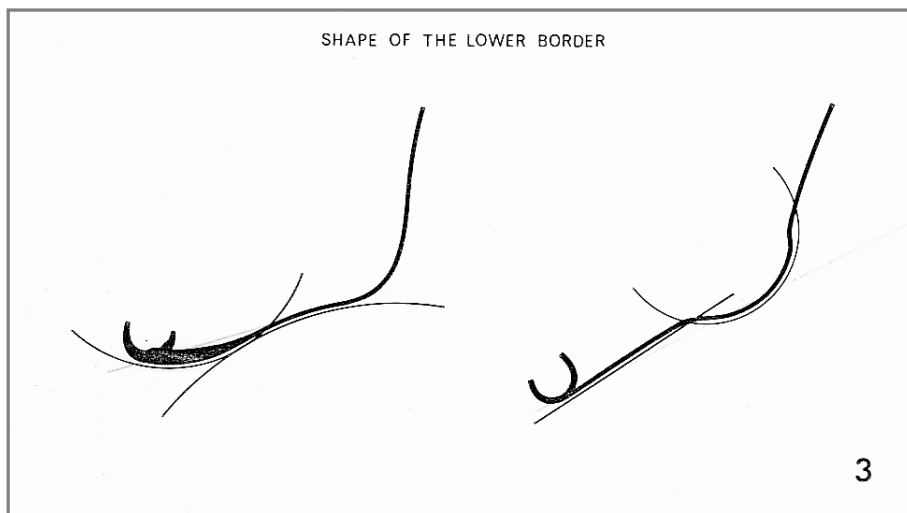
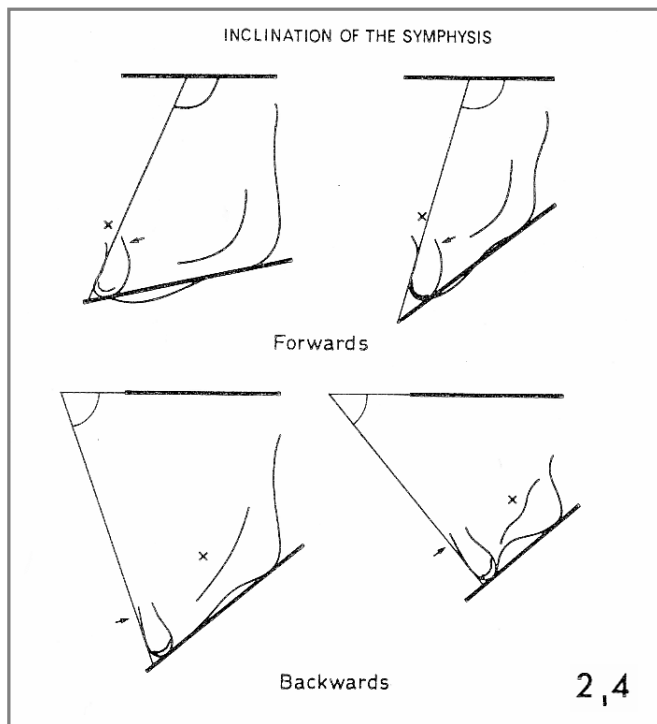


Fig. 5. Three types of rotation of the mandible during growth. A, Forward rotation with the center at the incisal edges of the lower incisors. B, Forward rotation with the center at the premolars. C, Backward rotation with the center at the occluding molars.

APPENDIX II A - SYMPTOMS OF MANDIBULAR ROTATION

1. Shape of condylar process.
2. Flexion of mandibular canal
3. Shape of the lower border
4. Inclination of the symphysis
5. Inclination of teeth
6. Anterior lower face height



APPENDIX II B - SYMPTOMS OF MANDIBULAR ROTATION

