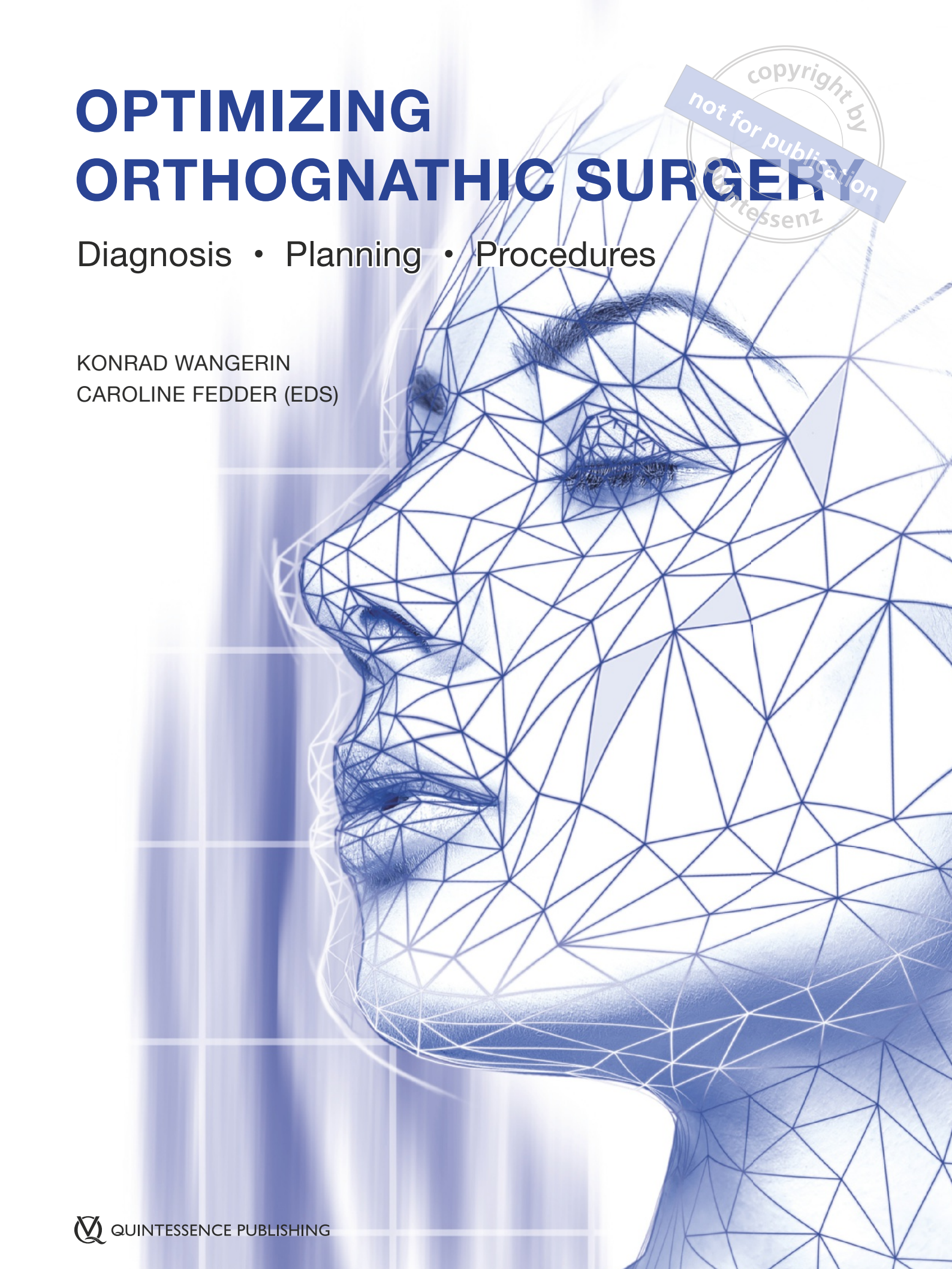
OPTIMIZING ORTHOGNATHIC SURGERY

Diagnosis • Planning • Procedures

KONRAD WANGERIN
CAROLINE FEDDER (EDS)



QUINTESSENCE PUBLISHING

1

Guidelines for photographic documentation of dentofacial malformations

Caroline Fedder

1.1 General

This chapter summarizes the guidelines for the photographic documentation of dentofacial malformations. To ensure that no impressions of the cheek retractor are visible in the subsequent photos, it is advisable to take the facial photos first, followed by the intraoral photos.

1.2 Facial photography

1.2.1 Equipment

In order to enable measurement on the photos after printing, the patient and the photographer must be positioned at the correct distance in order to obtain a true-to-scale printout on DIN A4 (Fig 1-1).

Markings on the floor for the patient's and the photographer's chairs ensure that the photographer is always at the same defined distance from the patient. If necessary, markings can be placed for standardized rotations (90/45 degrees) of the patient on the floor and/or on the wall.

A solid color background should be used.

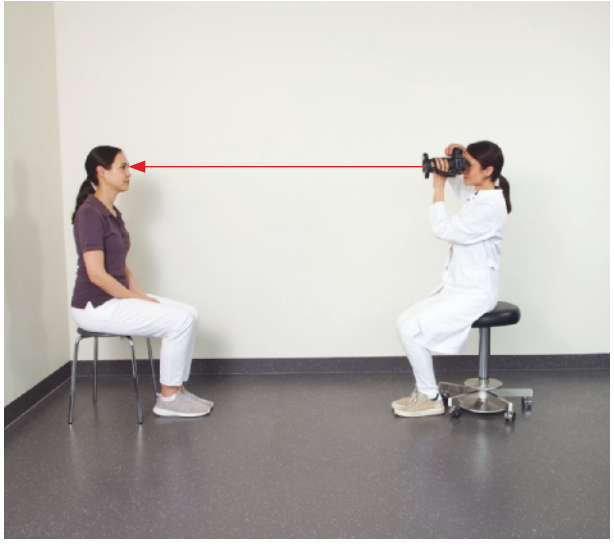


Fig 1-1 Positioning of the camera at the same height as the eyes of the patient.

1.2.2 Camera / photographer

The camera should be positioned on a tripod, or photographer positioned on a chair with castors adjustable in height using the feet. This allows the camera to be held at the level of the patient's head (Fig 1-2), and the photographer's hands to remain on the camera.

For precise adjustment of half-profile images, the photographer can roll to the side on a circular path without changing his or her posture.

1.2.3 Patient

Position the patient on a height-adjustable swivel chair or chair with a small headrest that does not take up too much space during the exposure.

Large earrings, jewelry, scarves, caps, glasses, etc, should be removed. Long hair should be tied up and tucked behind the ears. Eyes should be open so that the pupils are visible. The patient should sit upright with a straight spine. Shoulders should hang relaxed. Both soles of the feet should be placed completely on the floor.

The head should be kept straight so that the Frankfort horizontal line and interpupillary line are parallel to the floor (except for the frontal image in habitual posture) (Figs 1-3).

There should be sufficient distance to the background to avoid a drop shadow, or a slave flash can be used.

Fig 1-2a Positioning of the camera at the same height as the eyes of the patient (red line), and positioning of the patient's head so that the Frankfort horizontal plane (yellow line) is parallel to the floor.

Fig 1-2b Positioning of the interpupillary line parallel to the floor.

Fig 1-2c Positioning of the Frankfort horizontal plane parallel to the floor.

Fig 1-3 Habitual head position.

Fig 1-4 Frontal view with relaxed lips.

1.2.4 Recording

The entire head with attachment of shoulders should be photographed (caudal, eg, to the suprasternal notch).

For profile pictures, crop the image from the hair at the back rather than the tip of the nose at the front if cropping is required.

Frontal view in habitual posture

The patient should sit down on the chair and hold their head in their individual "natural" posture. The neck and the base of the shoulders are included in this photo, so that the posture can be judged.

It is important to check whether the patient is holding their head at an angle. Referral to an orthopedist may be necessary for assessment of the cervical spine/vertebral column (eg, scoliosis), or clarification of other syndromes (eg, hemifacial microsomia), depending on whether only the face is asymmetrical or if there is an additional scoliosis of the spine.

In the photographic example (Fig 1-3), the patient holds her head slightly tilted to the left and twisted to the right (the left tragus is more visible than the right).

All other frontal views

The eyes should be horizontal, so that the interpupillary line is parallel to floor.

The head should be kept straight (not turned or tilted). Check that both ears can be seen at the same distance, and note that the ears may stick out different amounts.

Frontal view with relaxed lips

This view is shown in Fig 1-4. In addition, here the teeth should be in resting position (let the patient hum "Mmmm" if necessary).

Lips must be relaxed (if necessary, have the patient moisten their lips with the tongue). In the case of lip closure insufficiency, the lips would be open accordingly.

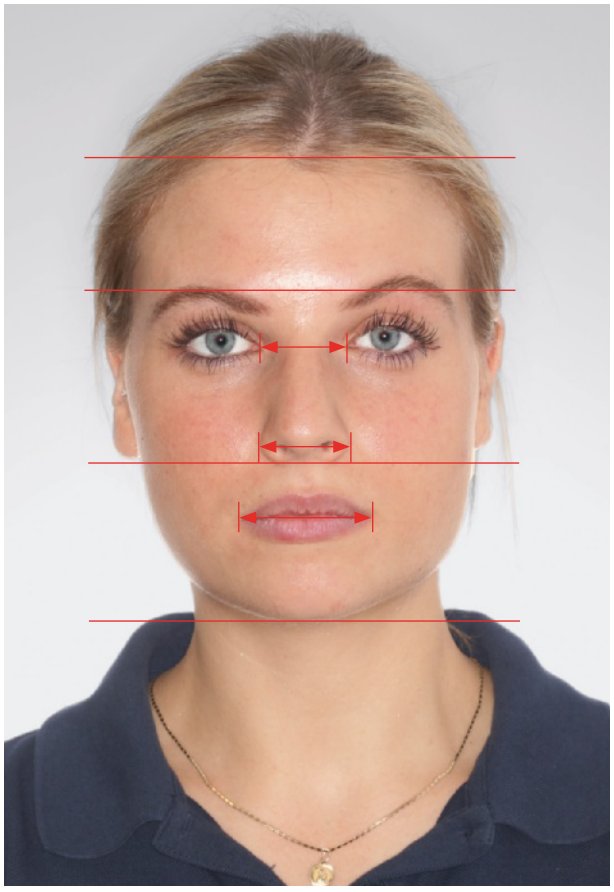


Fig 1-5 Frontal view showing the facial thirds, the distance between the median corners of the eyes, width of mouth, and alar width.

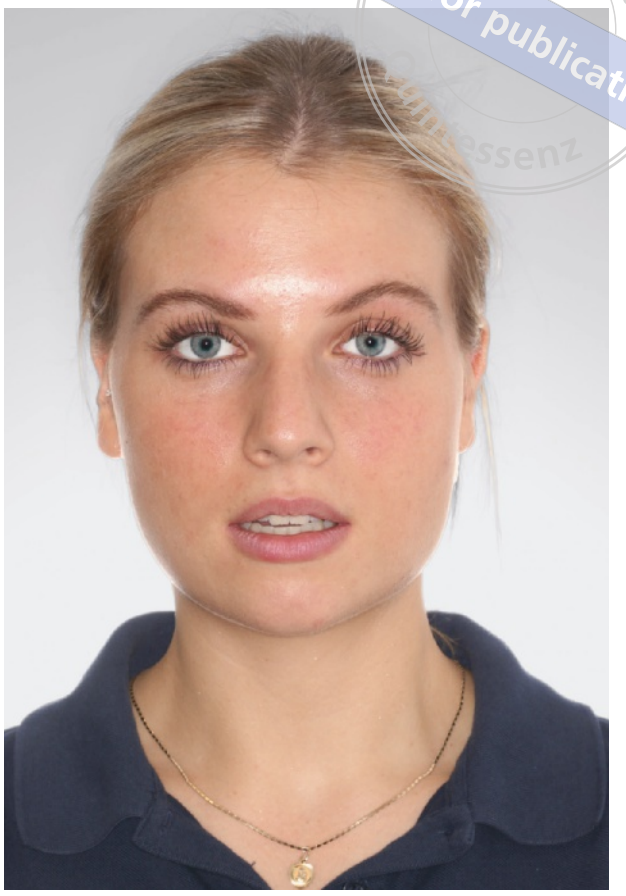


Fig 1-6 Frontal view with slightly open mouth.

This image is important to measure:

- zygomatic contour
- lip closure insufficiency
- the facial thirds (upper, middle, and lower face)
- the ratio of upper lip length to lower lip length, of lip white to lip red.

The photographic example (Fig 1-5) shows the following:

- Position of the facial thirds:
  - Upper face (UF) = hairline to glabella
  - Midface (MF) = glabella to anterior nasal spine
  - Lower face (LF) = anterior nasal spine to the underside of the chin
  - Target: UF/MF/LF = ⅓:⅓:⅓.
- Measurement of the width of thew oral fissure:
  - Target: not wider than the interpupillary distance.
- Measurement of the width of the nose (= alar base):
  - Target: corresponds to the distance of the median eyelid angles.

Frontal view with slightly open mouth

For this view (Fig 1-6), refer to the frontal view requirements above. The upper lip should be relaxed. Maxillary anterior teeth should be visible up to the incisal edg (if visible with relaxed lips).

This view is important for the following reasons:

- Assessment of the position of the bony maxilla in relation to the upper lip = maxillary anterior tooth show with the upper lip relaxed, to determine the vertical position of the maxilla in relation to the upper lip.

Fig 1-7 Measurement of the anterior maxillary teeth.

Fig 1-8 Frontal view smiling.

The photographic example (Fig 1-7) shows the following:

- Measurement of the maxillary anterior tooth show
- Target: 3 to 4 mm.

Frontal view smiling

For this view (Fig 1-8), refer to the frontal view requirements above. The patient should smile in a relaxed manner.

This view is important for the following reasons:

- Determination of whether the upper lip on smiling and laughing are different.
- Assessment of the symmetry and height of the anterior dental arch, and whether the dental arch is straight.
- Determination of facial symmetry. The interpupillary line in relation to the facial midline is important for determining the symmetry of the maxilla and mandible and as a basis for postoperative changes in the face.

Identification of the facial midline is demonstrated in the photographic example (Fig 1-9):

- Check that the photo is taken symmetrically: Is the head held turned? Are the ears the same size? Can the tragus be seen to the same extent on both sides? In this case, the patient has tilted her head slightly to the right.
- The interpupillary line can be drawn (between the two pupillary light reflexes): Check that the eyes are at the same level (they could be different eg, in case of hemifacial microsomia or after fractures). Only then can the reconstructed facial midline be used for surgical planning. Alternatively, the median eyelid angles can be used for reconstruction of the facial midline.
- Determination of the facial midline: Determine the midpoint between the pupillary light reflexes and draw down perpendicularly. Alternatively, deter-

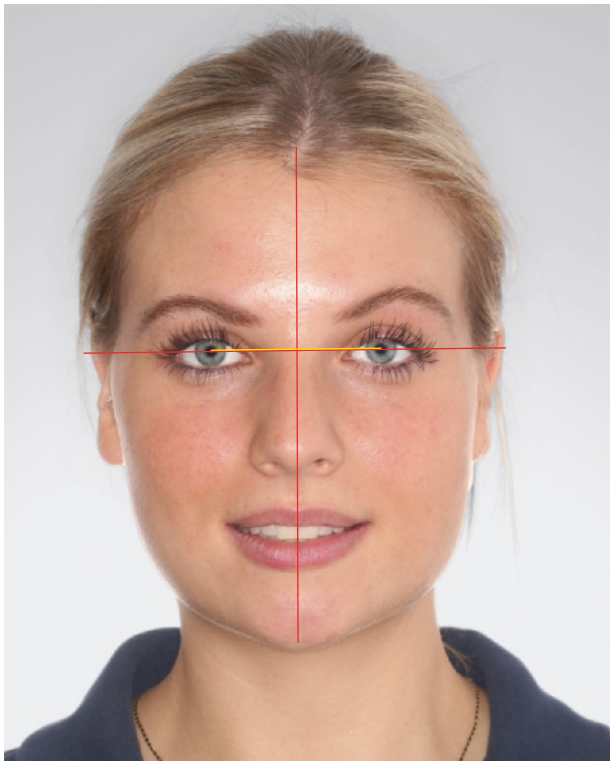


Fig 1-9 Interpupillary line (red horizontal line), determination of the middle of the face via half of the distance from the pupils (yellow lines), and identification of the facial midline (red vertical line).

Fig 1-10 Frontal view laughing.

mine the midpoint between the two median eyelid angles (to be used especially in case of unilateral strabismus) and draw down perpendicularly. Check whether the constructed facial midline is on the glabella/nasal bridge center. If not, is the photo really taken symmetrically (see above)?

- Determination of the lateral deviation to the facial midline of the nose tip, anterior nasal spine, philtrum, center of the maxilla (= approximal contact 11/21 [tooth numbering according to FDI notation]), center of the mandible (= approximal contact 31/41), and chin tip.
- Target: The tip of the nose, anterior nasal spine, upper lip, lower lip, and chin should ideally be in the middle.

Frontal view laughing

For this view (Fig 1-10), refer to the frontal view requirements above.

This is the natural maximum smile, and is important for assessment of:

- Anterior smile show
- Lip contour when smiling
- Whether a "gummy" smile is present (ie, part of the gingiva is visible)
- Buccal corridors (black triangles next to the maxillary posterior region) to determine the transverse width and shape of the maxilla. Note whether posterior teeth are visible, and any asymmetry of the lateral dental arch or canines.

The photographic example shows the anterior tooth show during laughter.

- Target: no or a low gingival smile.

Fig 1-11 Frontal view with spatula.

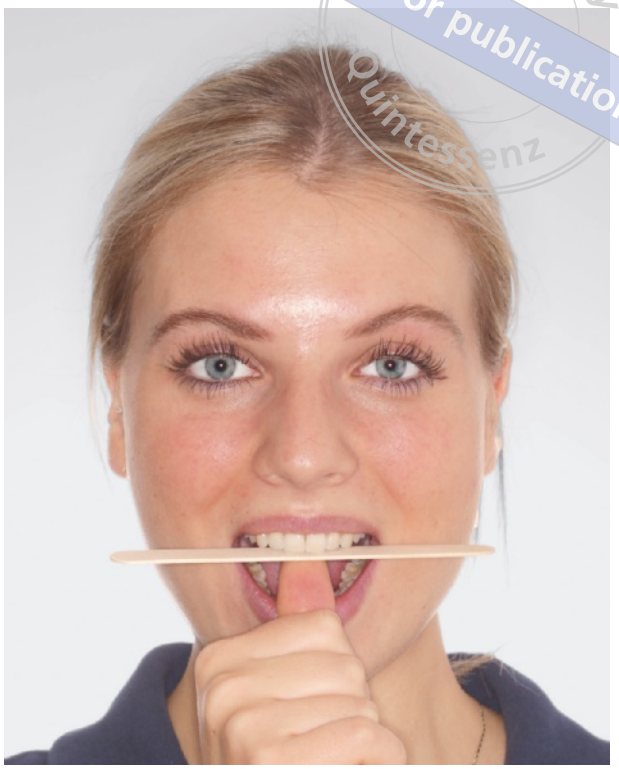


Fig 1-12 Frontal view with retained spatula.

Frontal view with spatula

For this view (Fig 1-11), refer to the frontal view requirements above.

Check beforehand that the spatula is not bent or twisted. Place the spatula on the tips of the maxillary canine. The patient should hold the spatula carefully with the teeth. The spatula must not be bent, but must remain straight. If necessary, have the patient hold the spatula from below with their thumb (Fig 1-12).

This view is important for the following reasons:

- Determination of the facial midline and the position of the tip of the nose, anterior nasal spine, maxilla, mandible, and chin in relation to the determined facial midline
- To check if the interpupillary line is parallel to the spatula (ie, if the maxilla is parallel to the interpupillary line).

The photographic example (Fig 1-13) shows the following:

- Determination of the correct position of the maxillary transverse plane:
  1. Draw the interpupillary line
  2. Connect the tips of the canines (lower red horizontal line)
  3. Draw the perpendicular lines down from the pupillary light reflexes to the top of the spatula (white arrows)
  4. Measure the distance on both sides (white arrows).
- Target:
  - the tip of the nose, anterior nasal spine, and center of the maxilla and the mandible should be in the middle of the face
  - the maxilla (= top of the spatula) should be parallel to the interpupillary line.

In the example, measured from the canine tips, this patient's maxilla is parallel to the interpupillary line.

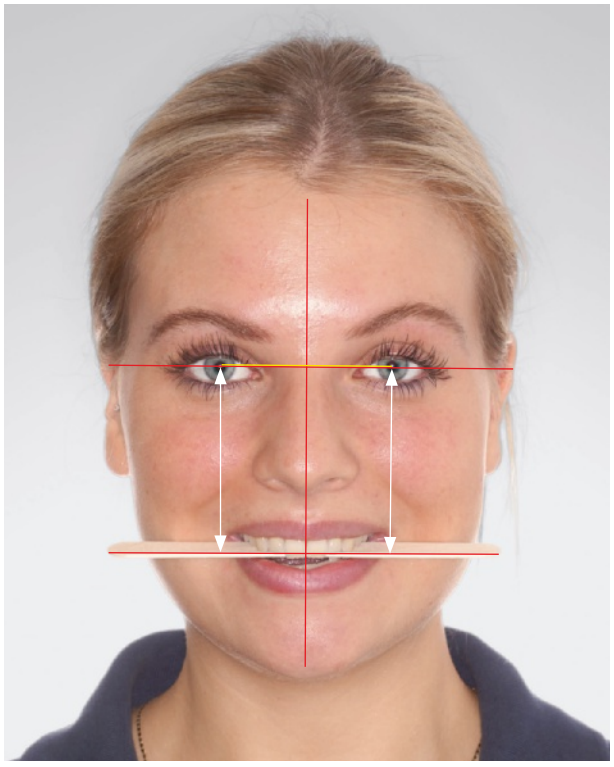


Fig 1-13 Determination of whether the transverse maxillary plane (lower red horizontal line) is parallel to the interpupillary line (yellow line).

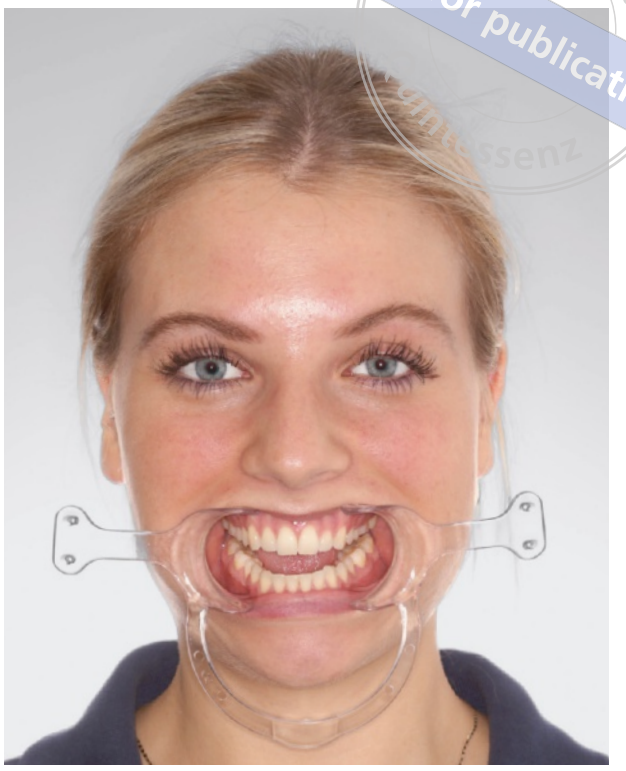


Fig 1-14 Frontal view with photo cheek retractors with tabs.

Caution: If the canines are differently abraded or a canine is intruded, this level cannot be used as a reference for the maxillary position. Alternatively, it is possible to use other teeth, ie the premolars, to determine the transverse maxillary plane.

Frontal view with photo cheek retractors

For this view (Fig 1-14), refer to the frontal view requirements above.

If canine tips 13 and 23 are not visible in the spatula photo, an additional photo should be taken with photo cheek retractors to determine if the maxilla is parallel to the interpupillary line (Fig 1-14).

Fig 1-15 Frontal view with open mouth.

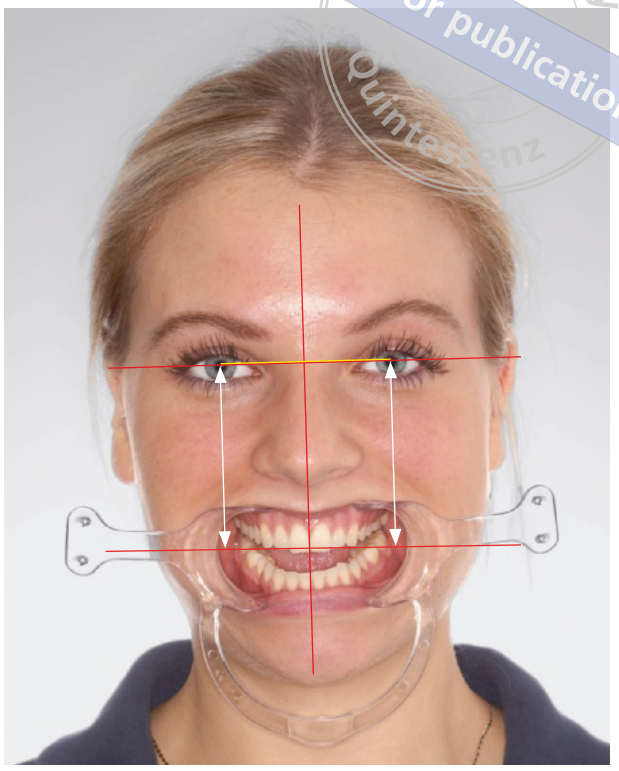


Fig 1-16 Determination of whether the transverse maxillary plane (lower horizontal line) is parallel to the interpupillary line (yellow line).

Alternatively, a photo can be taken without photo cheek retractors, but with the mouth open, showing the canine tips (Fig 1-15).

This view is important to assess whether the transverse maxillary plane (line connecting the canine tips 13 and 23) is parallel to the interpupillary line.

With the photo cheek retractors, it is additionally possible to see whether the patient has a "jaw" rotation of the maxillary molar region that requires correction.

The photographic example with the photo cheek retractors (Fig 1-16) shows the following:

- Determination of the correct position of the transverse maxillary plane (see Fig 1-13)
- Target: The line connecting canine tips 13 and 23 should be parallel to the interpupillary line, ie the maxilla is parallel to the interpupillary line.
- There should be no jaw rotation of the posterior maxilla, ie the molars are visible equally on both sides, as seen in the example case.

Frontal view from below

In this frontal view (Fig 1-17), the head is tilted backward until the tip of the nose is just below the level of the supraorbital rim.

This view is important for the following assessments:

- symmetry of the nostrils
- documentation of the width of the base of the nose
- basal nasal septal deviation
- symmetry of the zygomatic prominences
- symmetry of the mandibular rim/angles.

The photographic example (Fig 1-18) shows measurement of the width of the nose.

- Target: equal values of the width of the nose pre- and postoperatively, symmetrical nostrils, symmetrical and prominent zygomatic prominences, symmetrical mandibular rim and angles.

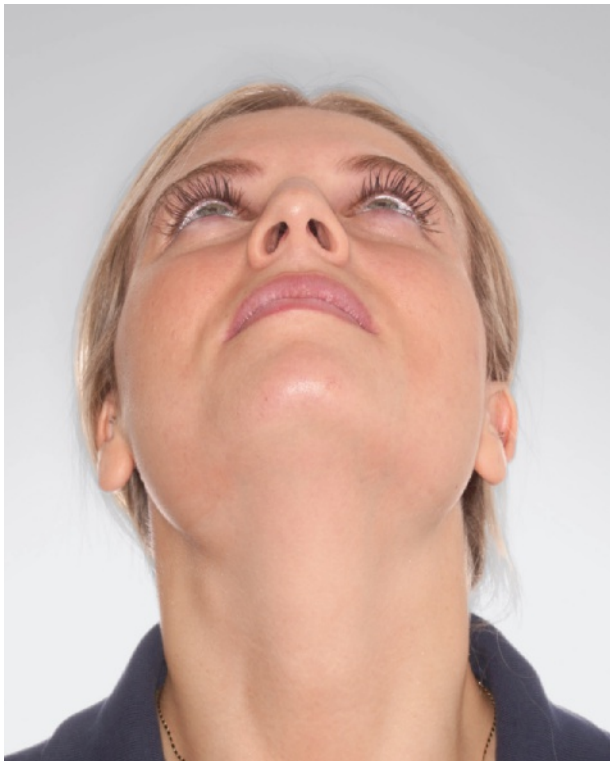


Fig 1-17 Frontal view from below.

Fig 1-18 Measurement of the alar width.

Profile view (90 degrees, right and left)

These views are shown in Figs 1-19 and 1-20. For all profile/semi-profile views, the following applies:

- The Frankfort horizontal should be parallel to the floor (Fig 1-21).
- The entire head with neck front and back/neck area and upper base of shoulder should be included.
- Teeth should be in resting position (let the patient hum "Mmmm" if necessary).
- Lips should be relaxed (if necessary, have the patient moisten their lips with the tongue); in case of lip closure insufficiency, lips are open accordingly.
- In the case of mandibular retrognathia, the patient should push the mandible backward to be able to document the extent of mandibular retrognathia.

In addition, the eyebrow on the other side should not be visible. However, there is a risk that the photo will be taken too far from the back and not enough of the face will be visible. If necessary, have the patient's head turned slowly or move around the patient on the chair until the eyebrow of the other side is no longer visible, and then take the photo directly.

This view is important for profile planning (eg, nasolabial angle, prominence of upper and lower lip, chin, later corrections of the nose, shape of jaw angle, documentation of masseter hypertrophy, neck contour, midface hypoplasia, position and shape of the ears). The photographic example (Fig 1-22) shows the measurement of the nasolabial angle.

- Target: women 100 degrees, men 90 degrees.

Fig 1-19 Profile view from the right (90 degrees).

Fig 1-20 Profile view from the left (90 degrees).

Fig 1-21 Orientation of the patient's head to the Frankfort horizontal plane (red line).

Fig 1-22 Measurement of the nasolabial angle.

Fig 1-23a Half profile view from the right (approx. 45 degrees) – the tip of the nose on the contour of the face.

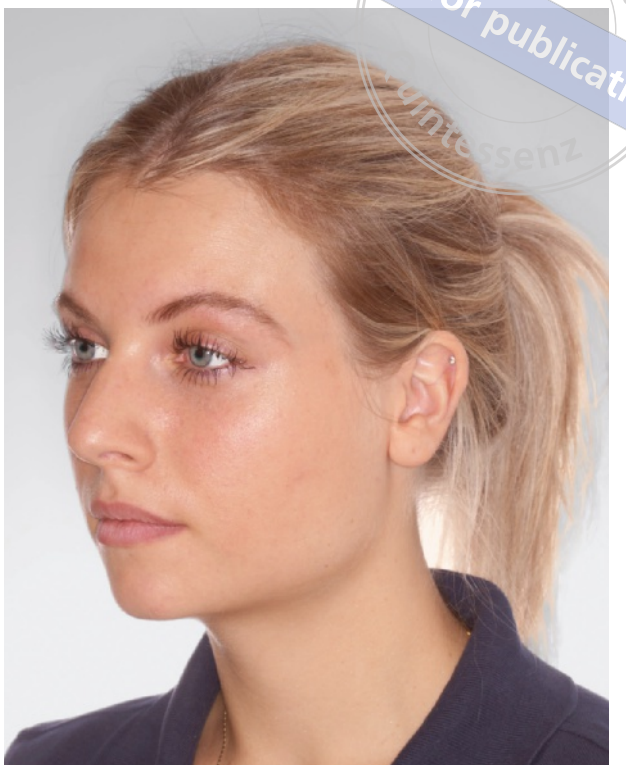


Fig 1-23b Half profile view from the left (approx. 45 degrees) – the tip of the nose on the contour of the face.

Fig 1-24a Half profile view from the right (approx. 45 degrees) – bridge of the nose on the median corner of the eyes (approx. 45 degrees).

Fig 1-24b Half profile view from the left (approx. 45 degrees) – bridge of the nose on the median corner of the eyes (approx. 45 degrees).

Half profile view (45 degrees, right and left)

For this view, turn the patient with their entire body 45 degrees to the side; this is sometimes difficult to reproduce. Alternatively, two images can be created, as these are easier to reproduce individually:

Half profile view I (approx. 45 degrees, right and left)

For this view (Figs 1-23), turn the patient with the entire body 45 degrees to the side and then move around the patient until the tip of the nose coincides with the contour of the face; this is easy to reproduce individually (exception: if necessary, postoperatively after correction of the tip of the nose).

This view is important for the shape assessment of the jaw angle, asymmetries of the skull shape, and ears/position of the ears.

Half profile view II (approx. 45 degrees, right and left)

For this view (Figs 1-24), turn the patient with entire body 45 degrees to the side and then move around the patient until the opposite median eyelid angle is just visible behind the bridge of the nose; this is also easy to reproduce individually (exception: possibly postoperatively after correction of the bridge of the nose).

This view is important for assessment of the zygomatic bone contour and to reveal asymmetries of the skull shape.

1.3 Intraoral photos

The general guidelines for taking intraoral photos are as follows:

- Photograph in a sitting position, eg, place the patient crosswise on the dental practitioner's chair so that the patient's legs hang down to the side (Fig 1-25).
- The necessary equipment is shown in Fig 1-26.
- Acquire intraoral images before taking the impression, as otherwise impression material residue could remain in the oral cavity.
- Use intraoral mirrors, possibly also in oversize.
- Warm up the mirrors so that they do not fog up; if necessary, blow dry with a multifunctional syringe such as Sprayvit (Dentsply Sirona) shortly before taking the photo.
- Let the patient breathe through the nose.
- Use cheek retractors to retract the lips; the teeth and marginal gingiva should be fully visible and not covered by the lips.
- Carefully aspirate saliva and blow saliva bubbles from the occlusal surfaces/out of the vestibule.
- Even in the case of asymmetric dental arches or partial dentition, the complete alveolar ridge should be acquired laterally.
- The display should include the alveolar ridge, aspect ratios, mucogingival border, gingiva, and alveolar ridge width.
- If the tongue is large and partially covers the teeth, one image should be taken with the tongue covering the teeth and one should be taken with the tongue held back over the mirror to image the entire occlusal surfaces.

1.3.1 Terminal occlusion, frontal view

This view (Fig 1-27a) is taken with the photo cheek retractors in situ. The patient or the dental hygienist pulls lightly on the tab on the cheek retractors from both sides (Fig 1-27b).

The focus should be on the canines for maximum depth of field (Fig 1-27c). The occlusal plane should be photographed horizontally or slightly from above. The patient should guide the mandible backwards into maximum Angle Class II occlusion, if they have an Angle Class II retrognathia with Sunday (dual) bite. The aim is to achieve a symmetrical view, with the dental arch center in the middle of the photo. Hold the lips away from the teeth, especially in the anterior mandible. The view should show the complete maxillary and mandibular arch and the maxillary and mandibular vestibules.

This view is important to show the course of the gingiva, the overview periodontal status, mucosal bands, mucosal thickness, recessions, the canine position (to assess whether one canine is higher than the other or if the entire maxilla is crooked), and abrasion.

If the patient has a constrained terminal occlusion, take one picture in their terminal occlusion and one with the first occlusal contact.

Fig 1-25 Positioning of the camera and head of the patient for intraoral photography.

Fig 1-26 Equipment required for intraoral photography.

Fig 1-27a Terminal occlusion, frontal view.

Fig 1-27c Focusing of the camera on the canines (yellow stars).

Fig 1-27b Positioning of the camera at the same height as the mouth of the patient (red line).

Fig 1-28a Terminal occlusion from the left.

Fig 1-28b Focusing of the camera on the first premolars (yellow star).

Fig 1-29a Terminal occlusion from the right.

Fig 1-29c Focusing of the camera on the first premolars (yellow stars).

Fig 1-29b Positioning of the camera and patient for documentation of lateral terminal occlusion.

1.3.2 Terminal occlusion, left lateral view

This view (Fig 1-28a) is taken with the photo cheek retractors in situ. The patient turns their head slightly to the right and pulls the tab on the cheek retractors to the left posteriorly.

The focus is on the first premolars (Fig 1-28b). The occlusal plane should be photographed horizontally or slightly from above. The patient should guide the mandible maximally backward in Angle Class II patients, especially in the case of Sunday bite, to show the original dimension of the mandibular retrognathia.

This view should show the approach of the canines of the opposite side to at least the first molars of the same side.

It is important for assessment of occlusion, gingival conditions, mucosal bands, and periodontal conditions.

Fig 1-30a Maxillary top view.

Fig 1-30c Focusing of the camera on the second premolars (yellow stars).

Fig 1-30b Positioning of the camera and patient for documentation of maxillary top view.

1.3.3 Terminal occlusion, right lateral view

For this view (Fig 1-29a) see the left lateral view above. The patient turns their head slightly to the left and pulls the tab on the cheek retractors to the right posteriorly (Fig 1-29b). The focus is again on the first premolars (Fig 1-29c).

1.3.4 Maxillary view

Using an intraoral mirror, and retracting the upper lip with lip retractors or dental mirrors, this view is taken at maximum mouth opening (Fig 1-30a and 1-30b).

The focus is on the second premolars (Fig 1-30c). The aim is for a symmetrical view. If possible, do not let the mirror rest distally on the maxillary teeth, but press it down so that there is some space between the mirror and the teeth. The entire dental arch should be seen as vertically as possible, from above. This view is important to show the presence of the teeth, symmetry of the dental arch, and position of the dental midline to the palatal raphe.

Fig 1-31a Mandibular top view.

Fig 1-31c Focusing of the camera on the second premolars (yellow stars).

Fig 1-31b Positioning of the camera and patient for documentation of mandibular top view using a contrastor and dental mirror.

1.3.5 Mandibular view

For this view (Fig 1-31a), the patient should pull their head into their neck, and hold the lower lip with a lip retractor, contrastor, or dental mirrors, to show maximum mouth opening (Fig 1-31b). The neck can be supported by the dental assistant if necessary.

The focus is on the second premolars (Fig 1-31c). The aim is for a symmetrical view. The tongue should be held back over the mirror or pressed back with the mirror to relax the tongue, keep the floor of the mouth free, and ensure that no teeth are hidden from view. If possible, do not allow the mirror to rest distally on the teeth, but press it cranially. Also vacuum carefully.

The entire dental arch/alveolar ridge with marginal gingiva should be seen as vertically as possible from above, including the floor of mouth with the lingual frenulum.

If the patient has an excessive pharyngeal (gag) reflex, leave the tongue on the floor of the mouth and make sure that the teeth are not covered occlusally by the tongue.

This view is important to show the presence of teeth, and the symmetry of the dental arch.

15

Transverse maxillary distraction

Konrad Wangerin
Christopher-George Hepburn
Andreas Burger
Björn Ludwig

15.1 Indication

Key words: *anterior tooth grinding, anterior tooth protrusion, asymmetrical dental arch, crossbite, lip closure insufficiency, nasolabial angle, premolar extraction, restricted nasal breathing, ridge size < dental arch length, skeletal transverse discrepancy, transverse dental arch discrepancy, transverse dental arch discrepancy > 5 mm, two-stage intervention*

If orthodontic palatal expansion of the small maxilla is no longer possible due to advanced skeletal growth, surgical intervention is necessary. Transverse maxillary distraction is indicated when the apical base of the maxilla is too small for a crowding-free insertion of the teeth into the dental arch while avoiding extractions (alveolar ridge size < dental arch length). A typical symptom may be anterior tooth crowding. In such cases of narrow maxillary arches, narrow nasal entrances are commonly noticeable. Restricted nasal breathing is often a functional symptom, which leads to mouth breathing and, as a consequence, an open mouth.

Narrow maxillary arches with anterior crowding in relation to the mandibular arch are cited as a criterion for bony crowding of the maxilla. If, on the other hand, the anterior teeth are not crowded, posterior teeth that are almost parallel to each other may indicate a transverse crowding of the posterior maxilla that requires surgical correction. In both cases, unilateral or bilateral crossbites and edge-to-edge bites are common. Asymmetrical dental arches may also be an indication for transverse maxillary distraction if an asymmetrical formation or positional relationship of both hemimaxillae originating in the skull base/occiput has occurred. Surgical expansion is necessary to subsequently orthodontically coordinate the dental arch to the antagonistic dental arch.

Further considerations for the indication result from the orthodontic pretreatments during skeletal growth: Situation models are not always sufficient for diagnostics if the attention of the person treating first is preferentially focused on the coordination of the dentition. An additional anterior cephalometric radiograph is necessary to detect a transverse dental arch discrepancy with a narrow maxillary base.

Transverse maxillary distraction is also indicated if there is transverse overextension as a result of orthodontic arch shaping. This allows the maxillary base to be expanded palatally and the posterior segments to be straightened.

Maxillary anterior tooth crowding can be resolved by premolar extractions before or during the skeletal growth spurt in the course of orthodontic treatment. This reduces the outstanding 3D bony growth of the maxilla. This can lead to a steep position of the maxillary anterior teeth and a steep anterior guidance angle, with possible functional problems as a result. Furthermore, a reduction of the upper lip prominence and an increase of the nasolabial angle results. The alternative of transverse maxillary distraction alone can help avoid these esthetic disadvantages and preserve the native length of the dental arch.

Anterior crowding in the maxilla and mandible (dental arch length deficit with too narrow apical base) based on too narrow apical bone bases may indicate simultaneous transverse maxillary distraction and transverse mandibular distraction (dental arch = alveolar ridge).

If, in addition to a severe malocclusion, a transverse dental arch discrepancy is present, eg with a slight crossbite/edge-to-edge bite (< 5 mm in the molar region) in the maxilla, this can also be corrected by simultaneous maxillary multisegmentation during maxillomandibular osteotomy.

If the 5-mm distance is exceeded, two-stage surgical correction is more likely to be successful out of concern for transverse bony stability: first transverse maxillary distraction and 1 year later Le Fort I osteotomy, and if necessary maxillomandibular osteotomy.

15.2 Transverse maxillary distraction planning and distraction options

15.2.1 Planning

Key words: *clinical planning, model operation, radiologic planning*

The operation is planned, clinically, radiologically, and on the basis of a model operation.

Clinically, the completeness and intramaxillary symmetry or asymmetry of the maxillary arch, the tooth position within the dentition, the occlusal mismatch with the mandibular teeth, and the lack of width to the mandibular alveolar process can be determined.

The panoramic radiograph is essential for the general overview of jawbones and teeth and specifically for the evaluation of whether there is sufficient interdental space for the osteotomy. Anterior cephalometric radiography provides a complementary diagnostic aspect in the posterior alveolar process, which is clinically more difficult to see. Ricketts analysis can be used to compare the posterior transverse arch and alveolar process width of the narrow maxillary arch with the wider mandibular arch. With DVT or CT scans all bony or dental structures of the maxilla including the extent of the sinus recessions can be evaluated. A simulation of the extent of distraction, the vector of distraction, and the final occlusal result can be performed as well. The palatal placement of implants or screws for distractor fixation without damaging the dental roots can also be planned three dimensionally.

The alternative conventional model surgery with plaster casts allows the simulation of the result as well; however, the internal structures like dental roots, bone thickness, and sinus extent remain hidden.

15.2.2 Distraction options

Key words: *asymmetrical maxillary expansion, maxillary expansion anterior < posterior, maxillary expansion anterior > posterior, parallel transverse maxillary distraction*

If the distance to the transverse maxillary expansion is the same in the anterior and posterior arch region, a parallel expansion of the small maxilla can be performed with a unidirectional distractor:

- Bone-supported Rapid Palatal Expander (RPE; KLS Martin)
- Tooth-, bone-, or hybrid-supported hyrax screw (eg, Dentalline, Forestadent, Dentaurum).
- Implant-fixed Hyrax screw Brölex (Forestadent) (see section 15.6 and Fig 15-7).

If there is intramaxillary asymmetry, the distraction direction is also determined in the model operation to achieve symmetrically aligned maxillary partial arches at the end of the distraction, which can be orthodontically shaped into a symmetrical dental arch:

- Asymmetrical fixed bone-supported RPE (eg, KLS Martin)

If a larger transverse expansion is required in the anterior region than in the molar region during this model operation in order to establish a neutral occlusion to the mandible, then transverse distraction must be performed individually: anterior > posterior. The same applies to narrow maxillae with regular anterior position but narrow posterior regions. In this case, individual distraction is also required, but vice versa, mainly in the posterior maxillary region:

- Tooth-, bone- or hybrid-supported Maxpander (Medicon).

15.3 Distractor screws and anchoring methods

15.3.1 Distractor types

The medical technology market has led to an almost unmanageable supply of distractors. In the following remarks, the distractor screws preferred by the authors in the last three decades are discussed.

Hyrax screw

The Hyrax screw is a uniaxial expansion screw with two guide rails, which allows unidirectional parallel distraction of both parts of the maxilla. It can be tooth-, bone-, implant-, or hybrid-fixed. As a rule, the distraction distance is up to 12 mm (eg, Dentalline, Dentaurum, Forestadent). In individual cases it can be used for transverse widening of asymmetrical maxillas (Fig 15-1).

Screw-in-screw (RPE, Transpalatal Distractor)

By rotating an internally threaded cylinder around a screw in which another counter-threaded screw is fixed, both screws can be rotated out of the cylinder. The screw ends fix mobile bone bearing surfaces with sharp metal tips, which can be pressed into the lateral palatal walls and fixed with short monocortical screws. Distraction is unidirectional. Special attention must be paid to educating the patient to activate the screw. The maximum distraction distance depends on the cylinder length, which is available in different sizes (eg, RPE, KLS Martin; Transpalatal Distractor [TPD], Synthes).

Fan-type expansion screw (Ragno)

The fan-type expansion screw (Ragno screw, Leone) opens two metal rods hinged at the apex against each other in an angular manner. It allows an angular distraction of both

Figs 15-1a to 15-1e (*a*) A patient aged 23 years and 8 months presented with an asymmetrical small maxilla for treatment. (*b*) After planning the operation on plaster casts, maxillary transverse distraction was performed and a Hyrax screw was dentally fixed in an unusual oblique manner. (*c*) At the end of distraction, the distraction screw was immobilized. The asymmetry of the dental arch was almost compensated and the maxilla widened. (*d*) After the retention time of 6 months, the device was removed. The pressure marks can be seen. Simultaneously, fixed braces were applied. (*e*) Three months later, the dental arch was symmetrically aligned. (Orthodontist: Dr Christopher-George Hepburn; Maxillofacial Surgeon: Dr Julian Mauch, Göppingen, Germany)

parts of the maxilla and is usually anchored to the teeth. In the case of a preferably anteriorly intended transverse expansion, the apex of the fan screw should lie far posteriorly in the palate in order to achieve the desired expansion of the hemimaxillae with both pairs of distraction arms directed anteriorly. If the apex lies palatally further anterior and already at the level of the posterior distraction arm pair, transverse compression of the posterior anchor teeth occurs during activation. This also applies to the opposite application of the fan-type expansion screw (Leone).

Double expansion screw (Maxpander)

The double expansion screw consists of two expansion screws that are connected in parallel via a median-transverse sliding axis. The respective distraction arm pair associated with an expansion screw can be tooth-, bone-, or hybrid-fixed via ball-and-socket joints or dental ligament fixation modules. This enables individual biaxial transverse maxillary distraction, eg anterior > posterior or vice versa or biaxial up to 13 mm (Maxpander, Medicon).

15.3.2 Anchoring methods

Tooth-supported distractors

Key words: *dental fabrication necessary, instability of the maxillary expansion, long treatment time, necessity for abutment teeth, no previous periodontal disease, preoperative insertion by orthodontist*

Tooth-supported distractors have the advantage of being inserted preoperatively without surgical measures. However, the dental technical fabrication of the appliance is carried out beforehand after taking a maxillary impression. Four abutment teeth are required for anchorage. If these are not available, a combination with a bone anchor is conceivable. There is the disadvantage of long lever arms with eccentric fixation to the teeth, far from the palatal distraction gap. The risk of transverse recurrence is also increased because the palatal distraction gap narrows due to postoperative scar constriction. Tooth-supported distractors are not indicated in cases of periodon-

tal disease. The treatment time is long because complete orthodontic follow-up cannot begin until the retention period of 6 months has ended due to tooth fixation. This method is still widespread in Germany because of historical and actuarial reasons.

Bone-supported unidirectional distractors

Key words: *any tooth status, post-bleeding, regardless of previous periodontal disease, risk of dislocation of the jaw halves, risk of fracture of the palatal bone lamella, short treatment time and orthodontist starts after distraction end, technically demanding with activation problems*

Bone-supported unidirectional distractors (screw-in-screw) have the advantage of a short overall treatment time. The preoperative insertion of the multiband appliance saves the patient the arduous insertion after the end of the distraction phase. Orthodontic arch shaping can begin early at the end of distraction and quickly eliminates distraction-related dislocations of the two halves of the maxilla. Intraoperatively, dummies are used to select the appropriate size of RPE or TPD distractors depending on the existing palatal width. The appliance is attached bilaterally palatally of the distraction gap, has practically no lever arms, and acts directly and stably. Palatal root damage can be avoided after opening the access by precise inspection of the palatal bone surface. A disadvantage is occasional technical difficulties with spontaneous resetting of the screw. Intensive instruction of the patient performing the activation, their relatives, and the orthodontist are necessary. Rare occurrences are fracture of the thin palatal bone lamella or postoperative bleeding in the distraction phase. They can be successfully treated by changing to a tooth-supported distractor or by resetting the screw and compressing the wound.

Hybrid-supported distractors

Key words: *fracture prevention palatal, high stability due to anterior bone anchorage, necessity for a dental anchor, short treatment time and orthodontist starts after distraction end, unilateral combination with bone anchor if necessary*

Hybrid-supported distractors (anterior palatal bony, posterior dental fixed) combine most of the advantages of tooth-supported and bone-supported distractors. The orthodontic treatment can start at the end of the distraction, since only one disturbing dental band is available per molar region. If an anchor tooth is missing, a screw implant can be used as a substitute. There is no palatal secondary bleeding. There is high transverse stability due to the anterior bone anchorage, no stress on the thin palatal bone, and no risk of tooth root damage. The Benefit System with Hyrax Screw (Dentalline) and the Maxpander System with double expansion screw (Medicon) are available as distraction systems.

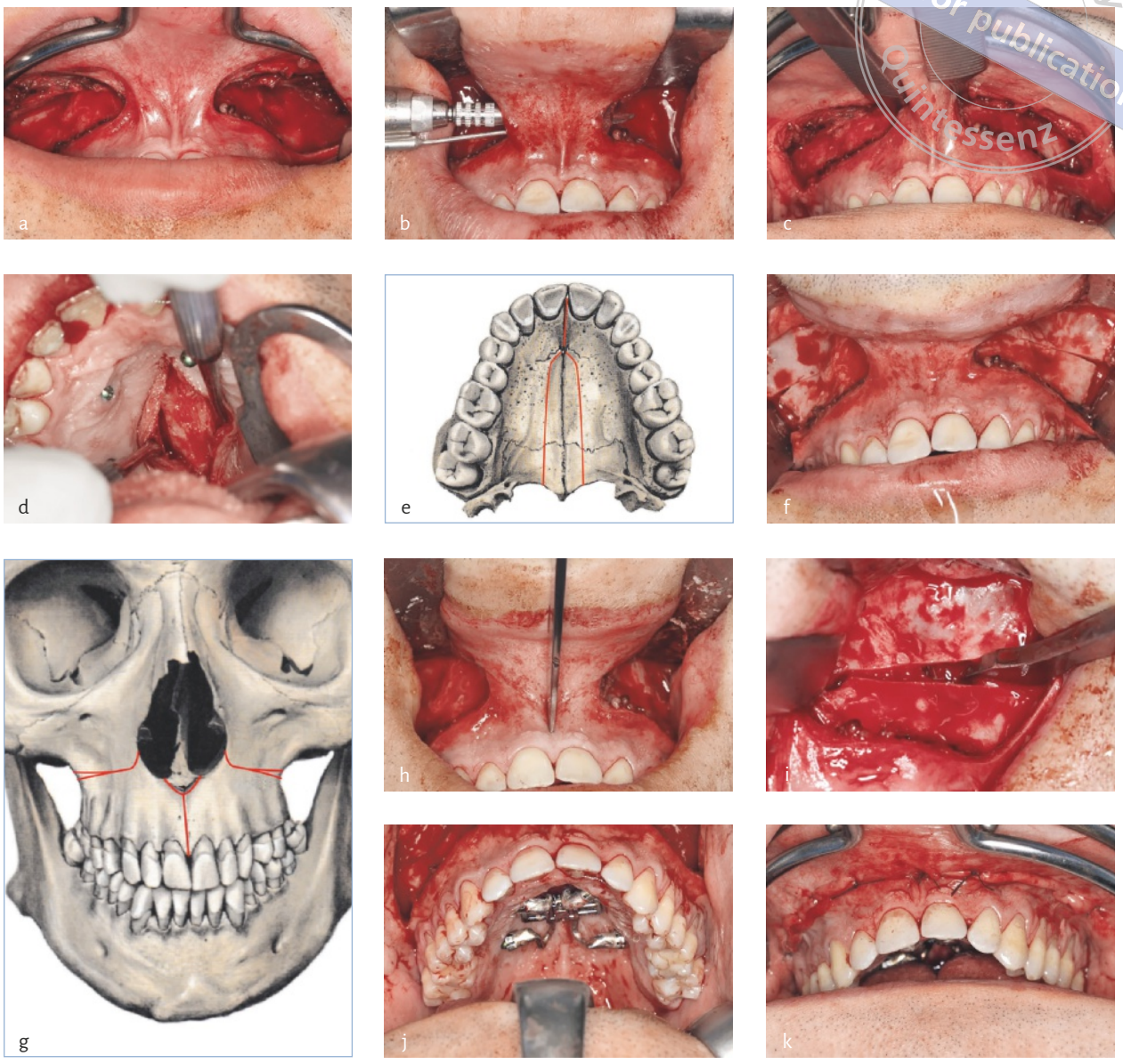
15.4 Surgical procedure

15.4.1 Preparation

Key words: *anchoring screws, impression taking and model fabrication, laser fixation, local anesthesia, model screws, prebending the distraction arms*

Case 1 (Fig 15-2) is used as an example of transverse maxillary distraction with a palatal bone-fixed double extension screw (Maxpander, Medicon).

On the day before surgery, four sterile anchoring screws were placed under local anesthesia (prilocaine 1% with epinephrine 1:200,000) bilaterally in the anterior and posterior palate in the region of the lateral incisor to canine and second premolar to first molar (2/3 and 5/6) palatally on both sides with the Phillips screwdriver without touching the roots of the teeth. After taking an impression of the maxilla with silicone material, the palatal recesses of the screw heads were filled with model screw heads and the impression was poured. The shoulders of the model screws were exposed and the click caps with positioning aids were placed on the model screw heads and tilted palatally up to the cup shoulder. The double expansion screw was rotated with its outer distraction arms into the position of preferred or increased distraction. All distraction arms were then bent to the click caps and laser-fixed. Because the click caps fit underminingly, the plaster cast was sawn up, the distractor was removed, finished, and was then available for intraoperative use.



Figs 15-2a to 15-2k (*a*) Case 1: Incision in the maxillary vestibule on both sides. (*b*) This leaves a median mucosal bridge, which is undermined to separate the superior nasal spine. (*c*) Subperiosteal free preparation of the entire maxilla to the maxillary tuberosity on both sides, and undermining of the mucosa of the lower nasal passages with raspatory. (*d* and *e*) Median palatal incision from the posterior nasal spine to the premaxilla, lateral undermining of the palatal mucosa, and paramedian sagittal transection of the palate on both sides, with retention of the nasal mucosa by raspatories located in the inferior nasal passages, and paramedian sagittal osteotomy of the palate on both sides to the incisive foramen to leave the septum untouched. (*f* and *g*) Removal of a narrow bone segment from the zygomatic alveolar crest bilaterally. (*h*) To avoid tilting of the hemimaxillae due to the subsequent distraction, the median interdental transection between the two central incisors is performed with a Lambotte chisel. (*i*) Finally the two maxillary portions are completely mobilized. (*j*) After palatal suture closure, the distractor is inserted by pre-expanding the two mobile maxillary halves, in this case a purely bone-supported Maxpander maxillary distractor. (*k*) Trial distraction is used to identify and eliminate interfering bony contacts, resetting to the initial position and vestibular suture closure (Maxillofacial Surgeon: Prof Konrad Wangerin) (*e* and *g*, Reproduced from Tillmann and Töndury,[1] by permission of Thieme Verlag).

15.4.2 Methodology

Key words: *control of palatal osteotomies, exposure of the vestibular and palatal surgical regions, inserting the distractor, intubation anesthesia, mobilization of the maxilla, Le Fort I osteotomy, local anesthesia, paramedian sagittal maxillary bilateral osteotomy, trial traction*

The procedure is performed under transnasal intubation anesthesia and begins with injection of local anesthetic and vasoconstrictor (eg, prilocaine 1% with epinephrine 1: 200,000) in the maxillary vestibule from first molar to first molar (region 16 to 26), followed by electrical or sharp scalpel incision of the mucosa in the maxillary vestibule from maxillary lateral incisor to first molar (regions 12 to 16 and 22 to 26) to the bone surface, leaving a mucosal bridge in the median (Fig 15-2a), free preparation of the canine fossa up to the maxillary tuberosity, undermining of the anterior maxillary region, exposure and separation of the anterior nasal spine, which remains pedunculated at the septum (Fig 15-2b), then mucosal loosening of the nasal floor on both sides with the raspatory (Fig 15-2c), and insertion of adrenaline-soaked pointed swabs for local hemostasis.

After median-sagittal mucosal incision at the palate, the mucosa is undermined bilaterally from the anterior transverse palatine folds (rugae) to the posterior nasal spine, then palatal paramedian sagittal maxillary osteotomy is performed bilaterally from the posterior margin of the hard palate through both nasal floors using a Lindemann burr or piezoelectrically, anteriorly converging to the incisive foramen (Figs 15-2d and 15-2e) without traumatizing it and without cutting the nasal floor mucosa, which is simultaneously held off with a raspatories (Fig 15-2c). The center of the palate with the cranially attached nasal septum remains unharmed in the sagittal midline of the palate.

Le Fort I osteotomy is performed from the piriform aperture to the pterygomaxillary notch bilaterally, with wedge-shaped bone segment removal at the zygomatic alveolar crest (Figs 15-2f and 15-2g). If necessary, in case of a very narrow nasal entrance, angular elevation of the osteotomy line is performed for bony widening of the bony nasal entrance and for accentuation of the nasolabial region. The bony walls between nose and maxillary sinus are preserved, and finally median transection of the maxilla with the Lambotte chisel from buccal between the two central incisors take place (Figs 15-2h), without deviating the septum. From the piriform aperture there is complete mobilization of both lateral maxillary portions including the tuberosity regions and control of the palatal-sagittal osteotomies with the chisel (Figs 15-2i and 15-2j). This is followed by suture closure palatally and insertion of the distractor, in this case clicking in the bone-supported individualized Maxpander distractor with its double extension screw (Fig 15-2k). This is followed by trial distraction with control of the osteotomies in the canine fossa and vestibular suture closure.

15.4.3 Surgical technique, the distraction process, and complications

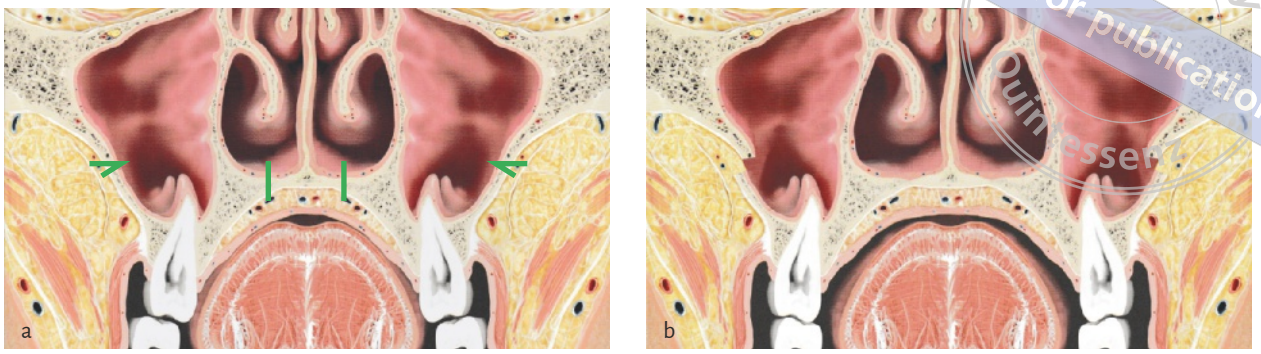
Key words: *avoidance of septal deviation, avoidance of synechiae in the nasal floor, dilatation of the inferior nasal passages, distraction course, distractor insertion, distractor replacement, Le Fort I osteotomy, minimization of surgical accesses, no lingual retainer necessary, pain, secondary corrections after 1 year, segmental osteotomy to zygomatic alveolar crest*

Prior to surgery, tooth-supported distractors (Hyrax or Ragno screw) are inserted on a trial basis by the orthodontist in charge of treatment to adjust the appliance and allow the patient to become accustomed to it for a short period of time. Intraoperatively, the distractor is removed for palatal access, and the distractor is finally cemented in place after palatal wound closure with Aqua CEM (Dentsply Sirona). This is followed by trial distraction, elimination of interfering contacts if necessary, and then resetting of the distractor to its initial position.

Minimization of surgical access reduces postoperative late sequelae. Leaving a mucosal bridge in the maxillary median region can help to avoid postoperative scarring of the mucosa, scar strictures with a feeling of stiffness, an uneven smile, laterally different upper lip contours, and later sensitization disorders in the maxillary vestibule.

As a rule, tooth loss in the median distraction gap is not to be feared and the preoperative fixation of lingual retainers is not necessary if the alveolar bone bed of the teeth close to the osteotomy is periodontally healthy and normally formed.

Bilateral bony segmental osteotomy at the zygomatic alveolar crest prevents unwanted tilting of the maxillary



Figs 15-3a and 15-3b This method expands the bony maxilla in a transverse direction, thus also expands the main airways through the inferior nasal passages, because the lateral nasal walls were not osteotomized but moved laterally. The tongue space is widened and thus the initial crossbite is eliminated. The palatal construction of the distraction fissure is usually bony, but in the case of larger distances it is also only scarred. In the area of the canine fossa and zygomatic alveolar crest it is securely bony at puncture contact points and stabilizes the two distracted maxillary portions in their new position. (Modified from Radlanski and Wesker,[2] with permission)

halves during distraction and allows real bony widening of the maxilla in the Le Fort I plane (Fig 15-3).

Once the Le Fort I osteotomy is complete, the maxilla is also mobilized on both sides in the pterygomaxillary region. The nasal septum and both lateral nasal walls remain untouched to permanently widen the inferior nasal passages by the transverse distraction.

The additional palatal surgical access is useful to perform a bilateral palatal osteotomy of the maxilla in a sagittal direction. Transverse distraction dilates both inferior nasal passages. The position of the median nasal crest with the cartilaginous and bony septum is not affected. Distraction-related septal deviation is thus avoided.

If the nasal floor mucosa is detached and retained prior to paramedian sagittal osteotomies, tissue disruption with subsequent scar strictures, septal deviations, synechiae, and obstruction of nasal breathing (as still occurs today after sagittal penetration of the maxilla with a chisel via a transmaxillary approach without preparation of the anatomical structures), can be excluded (Figs 15-2c and 15-2d).

After healing of the successful bony expansion of a narrow maxilla, a deviated septum can be straightened, shortened, median adjusted, and fixed with the transmaxillary septorhinoplasty in a second surgical session 1 year later. At the same time, the nasal floor, nasal entrance, anterior nasal spine, and turbinates can be inspected and corrected if necessary.

The selection of the appropriate distractor depends on the number of dental buttresses and the distance between the two posterior regions when tooth-supported distractors are used, or the distance between the two palatal bone walls when using bone-supported distractors. Ostensibly, narrow maxillae can be expanded intraoperatively in order to position the smallest distractor under tension. If the designed distraction distance of a distractor is not sufficient, a change of the device is necessary after maximum distraction. In such extreme cases, replacement of a bone-supported distractor under anesthesia is preferred.

Regarding the distraction course, as a rule, daily distraction of 3 × 0.2 mm is started on postoperative day 4. The younger the patient, the longer the daily distraction distance can be (up to 4 × 0.2 mm daily). The older the patient, the more restrained the extension of the maxilla (1 or 2 × 0.2 mm daily).

During the distraction phase, a sudden cracking noise may occur in the osteotomy area, causing the patient to become concerned. This is caused by interference in the osteotomy area or by additional chewing pressure. Pain may also be felt. Initially liquid, then strained food and reduced chewing pressure may be recommended to alleviate any discomfort. If local palatal bleeding during distraction occurs, the activation should be stopped, the distractor should turned back two times, and the whole palate should be covered with an additional nasal wound dressing, eg Coe Pak, GC.

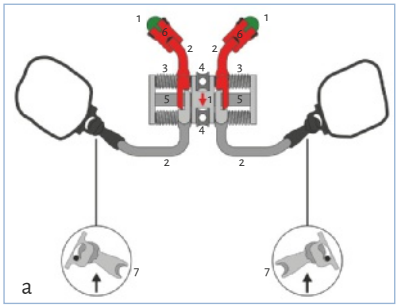
Figs 15-4a to 15-4h Even an asymmetrical dental arch due to non-attachment of a premolar can be symmetrized by asymmetrical positioning of a bone-supported RPE (size 3, KLS Martin) and distraction with simultaneous multibracket treatment under gap opening. *(a* and *b)* Preoperative situation. *(c)* Postoperative situation at the end of the active distraction phase. *(d)* At the end of the retention period 6 months postoperatively after maxillary expansion, with open palatal mucosal wounds. *(e* and *f)* Another 6 months later at the time of active gap opening in the region of the maxillary left first premolar (region 24) and occlusal fine adjustment. *(g* and *h)* Final result 8 years later, after implant placement and prosthetic restoration. (Orthodontist: Dr Christopher-George Hepburn; Maxillofacial Surgeon: Kiatanant Boonsiriseth, Thailand)

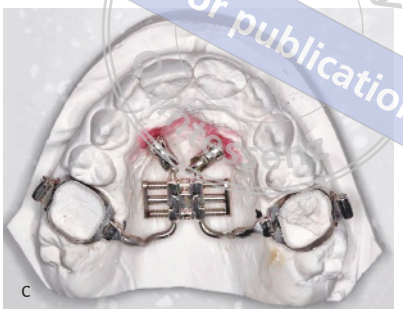
Note that even an asymmetrical dental arch due to non-attachment of a premolar can be symmetrized by asymmetrical positioning of the bone-supported RPE, and distraction with simultaneous multibracket treatment under gap opening (Fig 15-4).

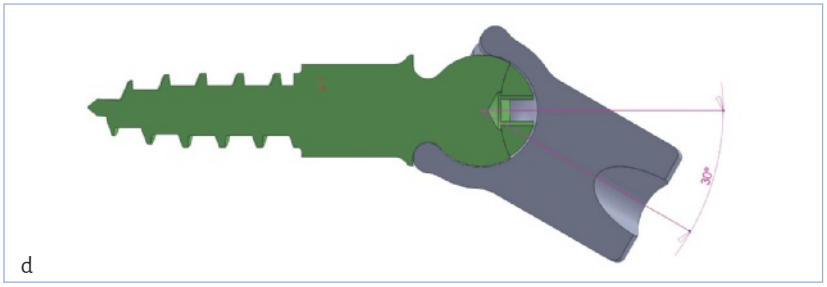
15.5 Maxpander maxillary distraction system

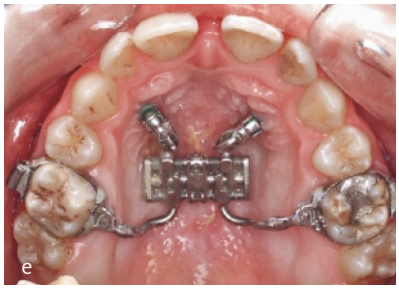
Key words: *articulated connections of both distraction axes, ball head click cap joint, bone fixation, distraction onset at outer distraction arm pair, hybrid fixation, mobile dental ligament fixation module, tooth fixation, trapped inner distraction arm pair, two connected expansion screws*

The Maxpander system (Medicon) consists of two stably connected expansion screws aligned parallel to each other, which together with two articulated connections per axis allow individual transverse maxillary expansions. Since the articulated connections can be bone- and tooth-fixed, the Maxpander maxillary distraction system can be tooth-, bone- or hybrid-anchored. This allows the individuality of the distraction to be combined with the advantages of hybrid fixation already demonstrated.





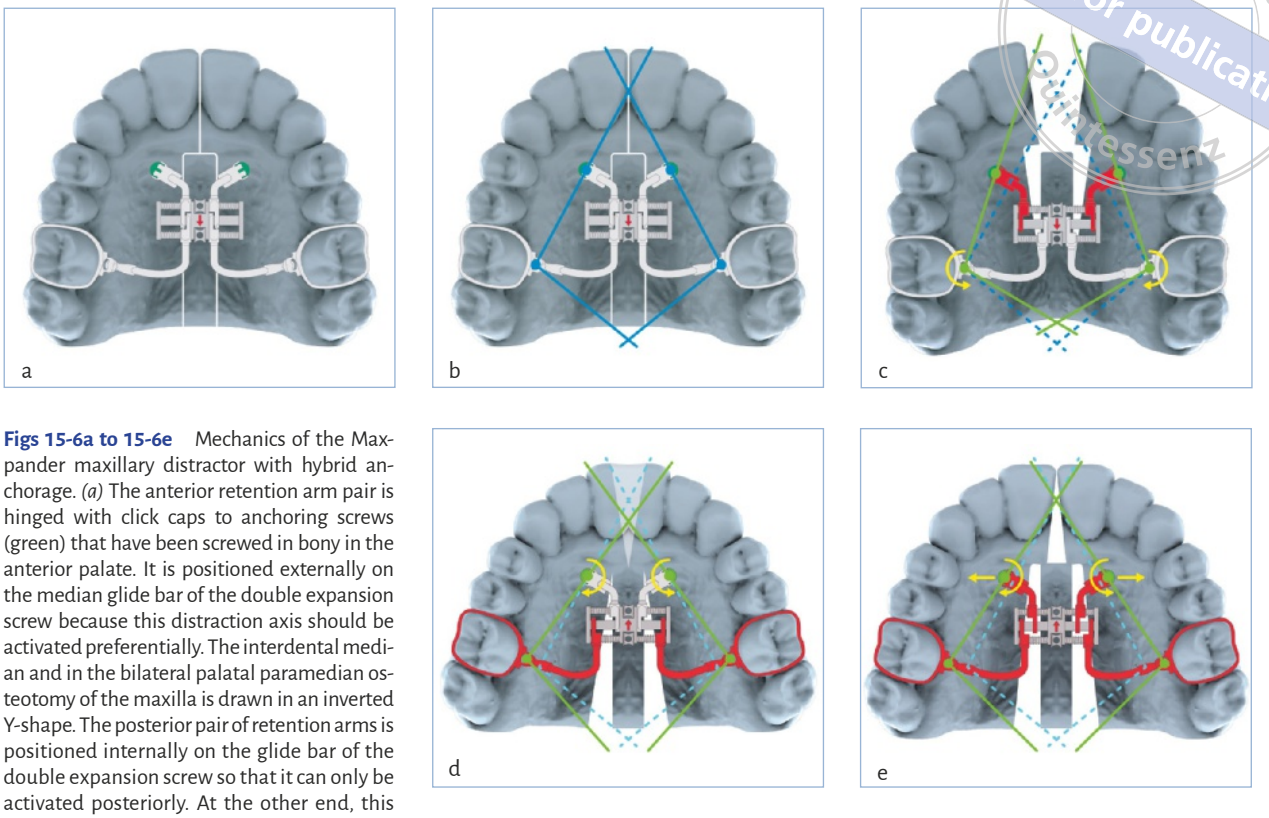




Figs 15-5a to 15-5f Transverse maxillary distraction planning (here with hybrid anchorage) begins with the determination of whether the anterior or the posterior maxilla must be further distracted. *(a)* The Maxpander double expansion screw is positioned with its outer distraction arm pair (red) at the point where the largest transverse expansion is planned. 1, Ball head of the implant screw. 2, Distraction arms or outer (red) and inner distraction arm pair. 3, Distraction screw for outer and inner distraction arm pair. 4, Activation part with cross hole. 5, Gliding bar. 6, Click caps. 7, Mobile tooth module. The inner distraction arm pair is trapped at the median glide axis and is activated inferiorly. Using the joint wrench, the corresponding distraction axis is activated first (red arrow shows direction of activation). *(b)* In the case of a hybrid anchorage, two ball head screws are placed obliquely in the anterior palate under local anesthesia without damaging the tooth roots, and at the same time the molar anchors are separated with rubber bands. *(c)* In the model operation, the Maxpander's outer pair of distraction arms are positioned in the anterior palate for more extensive distraction. Like the model, screws are placed in the impression of the maxilla, which are identical to the ball screws and are in the same position, and provided with click caps, which are tilted 30 degrees palatally up to the screw shoulder. The matching tooth bands on the molar anchors are provided with mobile tooth modules that are palatally aligned. After prebending, shortening, and adjusting both pairs of distraction arms to the articulated connections, laser fixation of all four contact points is preferably carried out to complete the Maxpander maxillary distractor. *(d)* The ball head screw offers the advantage that the screw head, which is used to screw in the screw, can also be used as a joint on which the click cap is placed. The circular shoulder of the ball head screw limits the movement of the click cap to 30 degrees, so that no bony tilting movements of both mobile halves of the maxilla can occur during subsequent distraction. *(e)* After prebending, shortening and fitting both pairs of distraction arms to the articulated connections, laser fixation of all four contact points is preferred to complete the Maxpander maxillary distractor. The clinical result 14 days postoperatively shows an anterior distraction of 8 mm and a posterior one of 4 mm. *(f)* Situation 3 months later, after orthodontic harmonization of the dental arch before removal of brackets and screws. (Orthodontist: Dr Christopher-George Hepburn, Ludwigsburg, Germany; Maxillofacial Surgeon: Dr Caroline Fedder, Ostfildern-Ruit, Germany)

In the drawing of a bone-fixed Maxpander (Fig 15-5a), it is shown that the outer distraction arm pair (red) of the double extension screw is the site of preferred or increased distraction. The inner distraction arm pair is trapped by its subordinate position on the median glide bar. Both distraction axes can be activated equally up to 13 mm.

In a hybrid case, the two anterior anchorage screws are placed first and the molar anchors are separated (Fig 15-5b). In the model surgery (Fig 15-5c), the outer distraction arm pair has been positioned anteriorly to start distraction there and distract further anteriorly than posteriorly. The two model screw heads have been provided with click caps that have been tilted palatally to the shoulder of the model screw (Fig 15-5d). The matching bands for the molar anchor teeth are first laser-fitted with a dental band fixation module (Fig 15-5e), which is aligned palatally. This is followed by bending, shortening, and matching of the two distraction arm pairs of the double expansion screw to the anterior click caps and to the posterior tooth modules. This is followed by laser fixation, as has already been done here, and finally cross-cutting of the plaster cast due to undercutting click



Figs 15-6a to 15-6e Mechanics of the Maxpander maxillary distractor with hybrid anchorage. *(a)* The anterior retention arm pair is hinged with click caps to anchoring screws (green) that have been screwed in bony in the anterior palate. It is positioned externally on the median glide bar of the double expansion screw because this distraction axis should be activated preferentially. The interdental median and in the bilateral palatal paramedian osteotomy of the maxilla is drawn in an inverted Y-shape. The posterior pair of retention arms is positioned internally on the glide bar of the double expansion screw so that it can only be activated posteriorly. At the other end, this retention arm pair is fixed to the dental ligament via a mobile element. *(b)* Click caps and mobile elements (blue dots) act as joints when the Maxpander is activated. Activation of the anterior distraction axis leads simultaneously to movement not only of the two anterior click cap joints, but also of the posterior mobile element joints and vice versa. Only the connection between the anterior and posterior distraction axis is immobile. *(c)* A maximum anterior transverse maxillary distraction of 13 mm by activating the anterior distraction screw alone leads to a V-shaped rotation of both anterior maxillary halves against each other. The overlapping of thin bone lamellae at the posterior nasal spine does not interfere in the rules because of the double osteotomy. *(d)* Preferred distraction in the posterior maxillary region requires 180-degree rotation of the double extension screw with posterior position of the outer distraction arm pair (red). Clinically, the implementation is limited. In the graphic representation, a sole posterior transverse maxillary distraction schematically leads to superimposition of the anterior region. In this case, the axes of rotation are the two-ball head click cap connections (yellow arrows). *(e)* However, if the anterior distraction screw is activated simultaneously in a stepwise subordinate manner, the maxilla is distracted almost in parallel. Increased posterior distraction can be performed up to the end of the diastema in each case.

cap margins with careful release of the tooth bands of the distractor from the model and completion of the Maxpander maxillary distractor. At the end of the distraction, a distraction of 8 mm and a posterior distraction of 4 mm are visible (Fig 15-5f).

15.5.1 Advantages and disadvantages

There are several advantages of the Maxpander system. A narrow maxilla can be expanded anteriorly > posterior and vice versa. The distraction axis of the outer distraction arm pair must first be activated. Both distraction axes can be activated equally up to 13 mm.

A hybrid anchorage combines a mobile osseous ball head click cap anchorage in the anterior palate with the advantage of an articulated dental module anchorage in the molar region.

The bony deficit of the maxilla can be compensated more precisely with the Maxpander than with previous methods. This shortens the orthodontic treatment required post distraction to form an arch congruent with the mandible. Hybrid distractions are also possible in

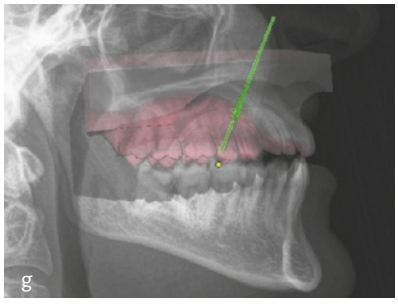


Fig 15-7a to 15-7m (*a* to *f*) Initial findings: maxillary crowding, transverse discrepancy, narrow maxillary width, bilateral reverse articulation, a tendency of anterior open bite, Angle Class III, and negative Wits appraisal. (*g* to *i*) Treatment planning. (*g*) Determination of the direction of implant insertion in the lateral cephalometric radiograph with OnyxCeph. (*h*) 3D surgical guide for two OrthoEasy Implants 1.7 x 8 mm (Forestadent). (*i*) Digital placement planning of the Brölex appliance. (*j*) Intraoperative situation after Le Fort I osteotomy and vertical osteotomy of the maxillary midline. (*k*) Sutures still in place after alveolodental surgical approach, 1 week postsurgery, medial separation of the wire for following distraction. (*l*) 12 days after start of distraction: transverse widening of 0.2 mm three times per day. (*m*) Median diastema after the end of 5-mm of distraction; the wire has already been changed to stabilize the maxillary incisors. (Orthodontist: PD Dr Björn Ludwig; Maxillofacial Surgeon: Dr Thomas Binger, Saarbrücken, Germany)

Figs 15-7n to 15-7s Final findings. Following molding of the dental arches and 1 year after first surgery, a BSSO of the mandible was performed (screws can be seen still in place), with resulting neutral occlusion, overcorrection in the molar region (red arrows), brackets removal, and final outcome after 15 months of retention.

free-end situations when an anchorage screw is placed in the edentulous alveolar ridge of the posterior region.

Clinical experience with Maxpander distraction to date has shown that congruent arch formation is successful and that subsequent Le Fort I osteotomy or maxillomandibular malocclusion correction can dispense with the need for subsequent maxillary segmentation, which was previously almost routine.

The disadvantages are the need for accurate surgical planning, control of the distractor function, and need for intensive oral hygiene.

15.5.2 Mechanics of the Maxpander maxillary distraction system

Two distraction axes that are stably connected to each other allow different distractions only if there is an articulated connection to the distraction object at both ends of each axis. Therefore, ball head screw heads with click caps are available for bony fixation and the dental ligament fixation module for dental fixation of the double expansion screw.

In the surgical planning, the alignment of the double extension screw is determined first. The distraction arms positioned externally on the median gliding axis are positioned anteriorly in Fig 15-6a because the larger or preferred transverse expansion of the maxilla is planned there. This will often be the case in the anterior arch region and rather rarely in the posterior. The posterior distraction axis with the inner distraction arm pair is trapped and can only be activated posteriorly up to the same distraction distance of 13 mm.

In the model example of a hybrid case, the different activation of both distraction axes leads to an additional rotation of both ball head click cap and tooth module joints (blue dots, Fig 15-6b).

In extreme cases, activating the anterior distraction screw alone results in opposite rotational movements in both posterior tooth module joints (red rotation arrows) to form an anterior V-shaped distraction gap (Fig 15-6c). This distraction movement to widen the anterior maxilla is only possible

without restriction because overlapping bone lamellae in the area of the posterior nasal spine are so thin and two-fold osteotomized that they do not interfere with each other.

In extreme cases, however, if only the posterior distraction screw of the outer distraction arm pair is activated when the distraction screw is rotated by 180 degrees, the anterior maxillary components are superimposed (Fig 15-6d). In this case, the two ball-and-socket joints are rotational axes acting in opposite directions (yellow rotation arrows). Clinically, a limitation of the distraction has already occurred due to the bony contact of the anterior maxillary portions. If the anterior distraction screw is also activated in a subordinate position, a median diastema can almost be avoided and an entire transverse maxillary extension can be individually designed (Fig 15-6e).

15.6 Case presentation: Implant-fixed Hyrax screw (Brölex)

Case 2 (Fig 15-7) is an example of the use of the implant-fixed Hyrax screw Brölex (Forestadent). A 36-year-old woman was diagnosed with mandibular prognathism, Angle Class III malocclusion, and bilateral reverse articulation. This was a combined treatment with transverse maxillary distraction with the bone-borne Brölex device and BSSO and orthodontics before, between, and after surgery. (Case and photos courtesy of PD Dr Björn Ludwig, Traben-Trarbach, Germany.)

15.7 References

1. Tillmann B, Töndury G (eds). Rauber / Kopsch: Anatomie des Menschen. Lehrbuch und Atlas. Band 1. Bewegungsapparat. Stuttgart: Thieme Verlag, 1987.
2. Radlanski RJ, Wesker KH. Das Gesicht. Berlin: Quintessence Publishing, 2012.

15.8 Further reading

3. Brown GVI. The Surgery of Oral and Facial Diseases and Malformations. 4th ed. London: Kimpton, 1938:507–511.
4. Bell WH, Epker BN. Surgical orthodontic expansion of the maxilla. Am J Orthod 1976;70:517–528.
5. Lines PA. Adult rapid maxillary expansion with corticotomy. Am J Orthod 1975;67:44–56.
6. Steinhäuser E. The midline-splitting of the maxilla for correction of malocclusion. J Oral Surg 1972;30:413–422.
7. Di Leonardo B, Ludwig B, Glasl B, Hourfa J, Mura R. BRÖLEX – Eine rein knochengetragene Expansionsapparatur. Kieferorthopädie 2016;30:149–152.

Successful results in orthognathic surgery begin with recognition and evaluation of the malocclusion and its accompanying symptoms. This comprehensive guide explains in detail the interdisciplinary treatment approaches from both clinical and radiologic perspectives, empowering the reader to adopt a systematic approach for their own patients.

Drawing on over three decades of surgical experience, the editors have thoughtfully curated a selection of safe and effective surgical methodologies. Each technique is meticulously elucidated through illustrated, step-by-step presentation.

This surgically oriented publication focuses on the simultaneous performance of several operations, including distractions to bridge significant gaps. It addresses the decision of whether to operate on the maxilla or mandible first, and examines the intricacies of managing multiple treatment sequences for complex malformations. Special emphasis is given to transverse jaw expansion, exploring different distractor options – bony, dental, or hybrid fixed.

Indications, limitations, and the prevention of complications and their solutions are explained. Clear descriptions of the 3D surgical planning of the entire facial skeleton and subsequent soft tissue procedures showcase the advances in facial esthetic surgery.

This invaluable resource serves as an unwavering compass for the treatment of both simple and complex craniofacial malformations, guiding practitioners on their surgical journey, providing the knowledge, techniques, and insights needed to deliver exceptional patient care and achieve outstanding surgical outcomes.

ISBN: 978-1-78698-121-9

9 781786 981219

www.quintessence-publishing.com