

SURGICAL MANAGEMENT OF MAXILLOFACIAL DEFORMITIES

Malformations of the maxilla and the mandible, even when mild, can produce a wide range of maxillofacial deformities which may be classified into 3 groups:

- 1) Congenital: may be unilateral or bilateral, e.g. those associated with Treacher-Collins syndrome, hemifacial microsomia, and cleft palate and alveolus.
- 2) Developmental: causes: congenital anomalies of adjacent structures like hemangioma; trauma like condylar fractures, infection like osteomyelitis, and endocrine imbalance like acromegaly.
- 3) Acquired: e.g. malunited facial fractures.

The resultant jaw deformities can either be skeletal or dento-alveolar.

I- SKELETAL JAW DEFORMITIES

Mandibular prognathism

Etiology: can be hereditary (Habsburgs family), due to trauma, or due to disease.

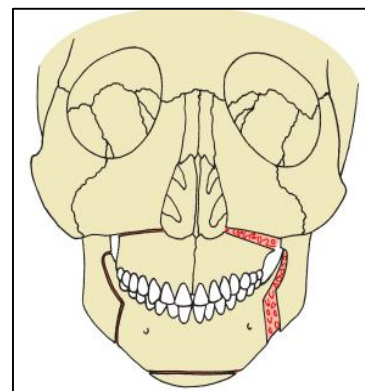
Classification: 4 patterns exist: prognathism with normal maxilla, prognathism with underdeveloped maxilla (the commonest type), prognathism with anterior open bite, and bimaxillary prognathism. Clinical features: acromegalic face, protruded chin and lower lip, concave facial profile, CIII occlusion, and anterior cross bite. When severe, eating and speech are affected. Cephalometric findings: ↑ SNB angle, and mandibular plane angle is frequently reduced. Treatment: mandibular set back after bilateral condylectomy, condylectomy with removal of bone from below the sigmoid notch, horizontal and oblique blind ramus osteotomy (Kostečka), or inverted L osteotomy (Trauner). However, the most commonly performed procedures nowadays are sagittal split osteotomy and vertical ramus osteotomy.

Mandibular retrognathism (micrognathism)

Etiology: may be congenital, developmental (trauma at birth or early growth), or acquired. Classification: unilateral or bilateral. Clinical features: short body of mandible, short ramus, retruded chin, bird face appearance, CII occlusion (mostly division 2), laterognathism and posterior cross bite (in unilateral cases), restricted mouth opening (when TMJ ankylosis exists). Cephalometric findings: ↓ SNB angle, and mandibular plane angle is often increased. Treatment: body elongation osteotomies (rarely used because of many disadvantages), vertical ramus osteotomy (for mild cases), and sagittal split osteotomy (most popular).

Mandibular laterognathism

A truly symmetric face does not exist. However, when the mandible deviates to one side beyond the average, facial asymmetry becomes clinically pronounced. Etiology: trauma to condyle in early life, congenital (hemifacial microsomia), unilateral condylar hyperplasia, or due to bone loss by surgery. Treatment: early intervention to improve growth potential or to restrict progressive growth may be necessary. A mandibular osteotomy alone may not completely resolve the skeletal asymmetry. Sagittal split + LeFort I osteotomy + genioplasty



may be required to establish facial symmetry.

Chin deformities

Microgenia: small receding chin may be an isolated deformity, associated with mandibular micrognathism, or even with mandibular prognathism. It may be hereditary or due to severe trauma to the chin. In cephalogram, SN-Pogonion angle is reduced. *Treatment:* chin augmentation by onlays, buccal inlays (extension of mandibular prosthesis), sliding genioplasty, or mandibular body osteotomy (rarely used).

Macrogenia: large chin is strongly related to hereditary factors. It causes prognathic (aggressive) appearance which may be acceptable in males but esthetically unpleasant in females. Macrogenia may be isolated or associated with mandibular prognathism. In cephalogram, SN-Pogonion angle is increased. *Treatment:* chin contouring by removing excess bone, or horizontal chin recession by sliding genioplasty.

Maxillary prognathism

Maxillary prognathism (of the entire maxilla) is a rare condition. However, protrusion in the anterior segment can be seen in patients with mandibular micrognathism. Severe maxillary protrusion can also be found when associated hemangioma or fibrous dysplasia exists. Excessive posterior maxillary width may produce unilateral or bilateral cross bite. *Treatment:* maxillary advancement by LeFort I osteotomy.

Maxillary retrognathism (micrognathism)

Posterior positioning of entire maxilla can be seen in patients with malunited midfacial fractures. Underdevelopment of skeletal maxilla is often seen in patients with cleft palate or craniofacial synostosis (e.g. Crouzon's disease). *Treatment:* anterior repositioning by LeFort I, II, or III osteotomies.

II- DENTO-ALVEOLAR JAW DEFORMITIES

Maxillary protrusion

Clinically: labial inclination of upper anterior teeth and convex profile in upper lip region. *Cephalometry:* PNS-ANS measurement and SNA angle are increased. *Treatment:* many cases can be treated by orthodontic therapy alone. When surgery is required, anterior segmental osteotomy or LeFort I osteotomy are useful options.

Maxillary retrusion

Clinically: retruded upper anteriors with normal molar occlusion, and retruded appearance of upper lip. Frequently associated with cleft palate deformity. *Cephalometry:* PNS-ANS measurement and SNA angle may be reduced. *Treatment:* maxillary advancement by anterior segmental osteotomy or LeFort I osteotomy.

Mandibular protrusion

Isolated mandibular protrusion is an uncommon deformity. Unlike prognathism, molar occlusal relationships are satisfactory. *Treatment:* many cases can be treated by orthodontic therapy alone. When surgery is required, set back can be achieved by anterior segmental osteotomy.

Bimaxillary protrusion

Clinically: thick incompetent lips. It is more common in Black and Oriental people than in Whites. There is often an associated microgenia. **Treatment:** extraction of first or second premolars + preoperative orthodontic therapy + anterior segmental osteotomies (upper: Wassmund procedure, lower: Köle procedure). Genioplasty and rhinoplasty may be required.

Open bite deformity (apertognathism)

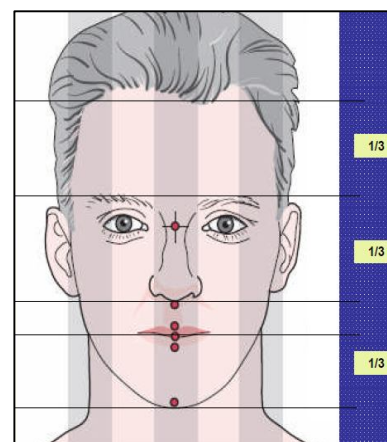
Failure of occlusion when the jaws are brought together. It may be anterior, posterior, or in both segments. **Clinically:** long lower third of the face, incompetent lips, upper incisor show at rest and gingival exposure on smiling, speech impairment, and difficulty in mastication. **Cephalometry:** ↑ anterior facial height (N-Me), steep mandibular plane, and height of ramus (Ar-Go) is often reduced. **Treatment:** in few cases, orthodontic therapy is adequate. When surgery is planned, anterior segmental upper and lower osteotomies, posterior upper segmental osteotomy (**Schuchardt** procedure), sagittal split osteotomy, and Le Fort I osteotomy are available options.



MANAGEMENT OF PATIENTS WITH MAXILLOFACIAL DEFORMITIES

History: chief complaint; medical and dental history; oral habits.

Clinical examination: **Extraoral:** the patient should be examined in a neutral position with the Frankfort horizontal parallel to the floor and teeth in centric occlusion. In the frontal view, the facial height is divided into 3 thirds by horizontal lines: the upper 1/3 from *trichion* to *glabella*, the middle 1/3 from *glabella* to *subnasale*, and the lower 1/3 from *subnasale* to *menton*. In the normal face, these thirds are usually equal. The lower 1/3 is further subdivided into 3 equal parts, the lips should meet near the junction of upper and middle thirds. Facial profile is also inspected which can be convex, straight, or concave. TMJ, ear, and neck should also be examined.



Intraoral: mouth opening, oral hygiene status, palatal and lingual anatomy, dental occlusion, lateral and protrusive movement of mandible, and deglutition.

Investigations: Radiographs including panoramic and lateral cephalometric radiographs along with a full series of photographs to evaluate the facial skeleton. Mounted study models are also required to simulate surgery and to fabricate intra-operative splints.

Indications of orthognathic surgery: skeletal deformities which are not amenable to routine orthodontic management like those in patients:

- who cannot retrude (or protrude) into an edge-to-edge occlusion i.e. Class III (or Class II) occlusion [overjet > 10 mm].
- with anterior open bites due to skeletal causes.
- with true asymmetry.

- with marked discrepancies in the vertical dimension.
- who are unwilling to accept appliance therapy.

Presurgical orthodontics

Objectives: 1) Proper alignment of teeth: by decrowding, space closure, and ideal inclination. Optimum occlusal relationship at the time of osteotomy contributes to long term stability of the mobilized skeletal segments.

2) Decompensation: skeletal malocclusion is usually accompanied by natural dental compensation which reduce the extent of real deformity. Teeth should be compensated to prevent occlusal discrepancies after surgery, e.g. expansion of maxillary arch to accommodate the wider portion of the advancing mandibular arch in the treatment of skeletal CII malocclusion.

3) Creating interdental space for segmental osteotomies.

Preoperative planning

After identifying the deformity, different patient's records can be utilized to simulate surgical procedures, to predict the outcome, and to define the operative plan. Simulated (mock) surgery can be performed on the following records:

- Mock surgery on dental study models (model surgery): Traditional model surgery can be used to transfer the workup to the operating room. A set of dental study models mounted on articulator enable to plan the surgical correction. After drawing marking lines on the cast corresponding to the planned osteotomies, the cast is sectioned at these lines and the segments are repositioned according to the type of surgery. The cast is then secured with sticky wax, and an acrylic splint is fabricated, to serve as an intra-operative guide of occlusion after repositioning.
- Mock surgery on cephalometric tracings: transparent sheets are applied on cephalogram and anatomical landmarks are traced on the sheets to simulate the planned surgical procedure and see the resultant profile.
- Mock surgery on photographs: a scissor is used to cut portions of the facial anatomy from the lateral photographs to allow measuring the magnitude and direction of skeletal and soft tissue change needed.
- Computer-aided planning: various hardware and software combinations are available that create 3-D images from cephalometric or CT data provided by the original scanner. Imaging software permits virtual osteotomies to be created that can be manipulated and repositioned according to the anticipated surgical plan.

MANDIBULAR ORTHOGNATHIC PROCEDURES**Sagittal split osteotomy (SSO)**

History: Hugo Obwegeser first developed this technique. He aimed to design an osteotomy that could be performed transorally with broad contacting bone surfaces. After studying cadaver mandibles, the first clinical case was performed in 1953, under local anesthesia. The initial osteotomy was limited to the ramus only. Over the next 30 years, multiple modifications by Obwegeser and others were suggested. The most common one currently performed include the buccal cortex of the mandibular body in

the area of the second molar. The original osteotomies were secured with wire osteosynthesis, while today's SSO includes rigid fixation.

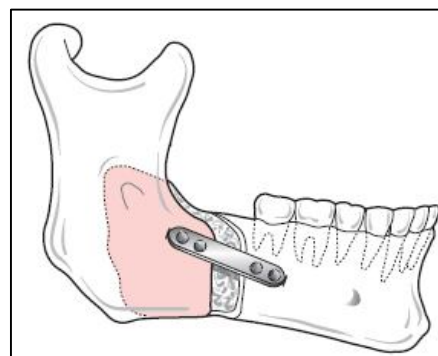
Indications: SSO is a versatile technique in that it allows wide range of mandibular movement, so it can be used for mandibular prognathism, retrognathism, and lateral deviations. It could also be used to correct anterior open bite (but relapse rate is high).

Contraindications: the presence of unerupted second molars; a severely narrow anteroposterior or mediolateral dimension of the ramus with no medullary bone between the buccal and lingual cortices; and significant mandibular asymmetry.

Advantages: avoidance of external scar because it is done intraorally; wide area of cancellous bone contact with rapid bone consolidation; wide range of positional changes between the fragments; minimum spatial alteration between condyle and glenoid fossa; and possible use of internal rigid fixation.

Disadvantages: high incidence (up to 80%) of lower lip altered sensation (anesthesia or paresthesia). *Limitations:* should not be used alone to close anterior open bite because of high rate of relapse.

Procedure: The incision typically extends 1 cm up on the anterior ramus and continues inferiorly along the external oblique ridge into the mandibular vestibule to the mesial side of the first molar, often with a vertical release. Subperiosteal dissection is carried to the inferior border of the mandible in the molar region. The anterior border of the ramus is stripped of the temporalis attachment to the tip of the coronoid. Dissection is also performed along the medial aspect of the ascending ramus to identify the sigmoid notch and the lingula.



The medial ramus corticotomy is completed with either a thin reciprocating saw or a bur. The osteotomy is then carried along the external oblique ridge and buccally down through the inferior border of the cortex. The junction areas between osteotomies should be checked for continuity. Then, a series of osteotomes of increasing width are used to achieve the split. Once the SSO is completed bilaterally, the mandible should be repositioned into its planned position. Bone trimming from either the proximal or distal segment is required in mandibular setback or rotation surgeries. Once the tooth-bearing segment of the mandible is repositioned and IMF performed, the SSO is rigidly fixated.

Vertical ramus osteotomy (VRO)

History: VRO first developed by Caldwell and Letterman in 1954, through an extraoral approach. Its novelty lay in that it was an osteotomy that minimized injury to the mandibular nerve. In 1970, intraoral approach was described. Some authors also championed VRO as a treatment of TMJ dysfunction.

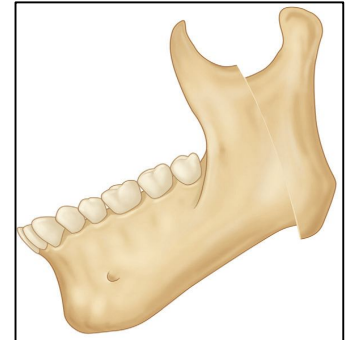
Indications: mandibular prognathism is the primary indication. VRO can also be used for mild mandibular retrognathism to advance the mandible for no more than 2 mm.

Contraindications: patients with tendency toward hypertrophic and keloid scar formation (extraoral approach); limited mouth opening (intraoral approach).

Advantages: facility of execution; avoidance of injury to the inferior alveolar nerve; and teeth do not have to be sacrificed.

Disadvantages: cutaneous scar and risk of injury to marginal mandibular nerve (extraoral approach); requires special instrumentation for exposure and osteotomy (intraoral approach); long postoperative IMF (3 weeks wire + 2-3 weeks elastics); unsuitable to use rigid internal fixation.

Extraoral approach: submandibular incision is made followed by dissection through the platysma muscle to expose the mandibular angle. The masseter muscle is raised from bone by subperiosteal elevation, from the lower border to the sigmoid notch. The osteotomy is made with a powered reciprocating saw from the deepest part of sigmoid notch to just anterior to the angle. After repositioning of distal segment, IMF is done.



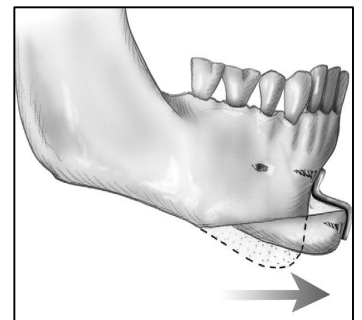
Intraoral approach: The incision starts on the anterior border of the ramus 1 cm posterior to the third molar region and sweeps forward into the buccal vestibule to the area adjacent to the first molar. Dissection of the lateral ramus is then performed antero-posteriorly until identifying the sigmoid notch and the posterior border of the ramus. Bauer retractors are placed in the sigmoid notch superiorly and at the antegonial notch inferiorly. Use of fiberoptic Bauer retractors is also helpful for illuminating the surgical cavity and maximizing visualization. VRO saw is used to create the osteotomy which should relate posterior to the antilingula, down the lateral ramus to the antegonial angle. Once bilateral VROs are completed, the mandible should be passively repositioned posteriorly into final occlusion. The proximal segments are lateralized. IMF is established, and the wound is irrigated and closed.

Oblique vertical ramus osteotomy (Thoma): the osteotomy is made from the sigmoid notch to a point posterior to the mandibular angle.

Inverted L ramus osteotomy (Trauner): the horizontal limb is made above the mandibular foramen, and the vertical limb dropped down behind the foramen, parallel to the posterior border of the ramus. *Indication:* treatment of mandibular prognathism.

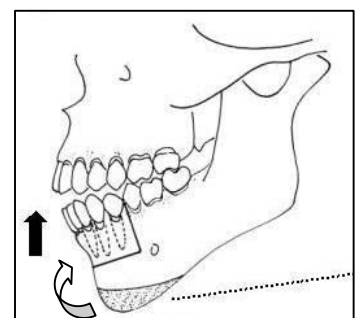
Sliding genioplasty

First described by Hofer in 1942 using external approach. Nowadays the procedure is done by intraoral degloving technique. An anterior labial incision is followed by subperiosteal dissection to the lower border and around the mental foramen. A powered saw is used for doing osteotomy. After repositioning, the mobilized segment is rigidly fixated by miniplates. *Indications:* correction of microgenia, macrogenia, or laterognathism, and in patients with vertical symphyseal abnormalities.



Anterior segmental mandibular osteotomies: Köle procedure

Procedure: A transverse anterior segmental osteotomy is made at least 5 mm below the teeth apices. The anterior open bite is closed, and the resulting defect is filled with bone taken from the inferior border of the symphysis. *Indication:* to correct minor anterior open bite and reduce the vertical height of the symphysis.



Mandibular body osteotomies: rarely used. The main drawbacks: possible injury to inferior alveolar nerve, creation of dental gaps, technical difficulties, need to provide soft tissue coverage for osteotomy sites, and need for bone grafts.

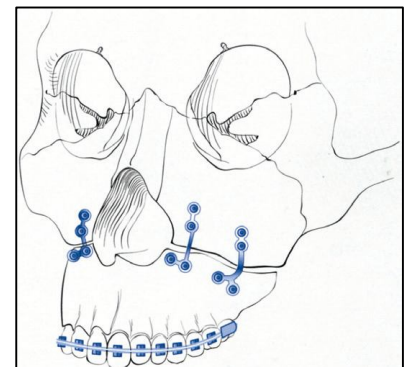
MAXILLARY ORTHOGNATHIC PROCEDURES

LeFort I Osteotomy

Indication: for treatment of maxillary retrognathism, maxillary protrusion, or skeletal open bite for maxillary advancing, setting back, or downfracturing respectively. Segmental LeFort I osteotomies can also be used to treat transverse maxillary deformities and to correct long face deformity.

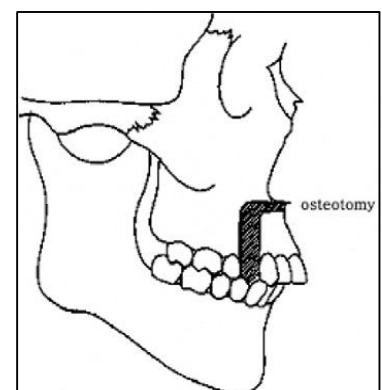
Procedure: Local anesthetic with vasoconstrictor is injected into the maxillary mucobuccal fold prior to giving general anesthesia to allow time for the vasoconstrictor to take effect. A circumvestibular incision, extending from first molar to first molar, is made through the buccolabial mucoperiosteum. Subperiosteal dissection begins at the piriform rim and is carried superiorly and laterally along the anterior maxilla, and then posteriorly toward the pterygomaxillary fissure. A fine periosteal elevator is used to elevate the nasal floor.

A reciprocating saw is used to make a horizontal osteotomy from the maxillary buttress to the piriform rim on each side. The nasal septum is separated from the nasal crest of the maxilla using a septal osteotome. The pterygoid plates are separated with a small, sharp and curved osteotome. After complete mobilization of maxilla is achieved, it can be repositioned forward or backward according to procedure, and temporary IMF is performed using the prefabricated oral surgical splint. Excess bone is removed and maxilla is rigidly fixated in the new position. Bone grafting is needed in advancement surgery. IMF is released and occlusion is checked before wound irrigation and closure, followed by definitive IMF.



Segmental maxillary osteotomies

Anterior segmental maxillary osteotomy is indicated primarily for correction of dento-alveolar protrusion. Other indications: correction of anterior open bite, closure of dental spaces between segments, and combined with other osteotomies to achieve optimal correction of dentofacial aesthetics and occlusion. Three techniques are available: in **Wassmund** procedure, a tooth (premolar) is extracted and a vertical bone cut is performed on the extraction space. The horizontal osteotomy between the canine root tip and the piriform rim is then carried out to connect the vertical osteotomies on the right and left sides. Horizontal osteotomy is also performed on palatal side. The planned osteotomy sites are reached by tunnelling under mucoperiosteum. The anterior segment is then pushed posteriorly and inferiorly by surgeon's fingers, and monomaxillary fixation is done with the posterior upper teeth.



In **Wunderer** modification, a palatal flap raised by means of a transverse incision of the palate, while the anterior osteotomy is made after tunneling, leaving the buccal blood supply intact. In **downfracture** technique, a buccal flap is raised, and the palatal osteotomy is made after tunnelling, leaving the palatal blood supply intact.

Posterior segmental maxillary osteotomy (**Schuchardt** procedure) can be used to close posterior open bite or anterior open bite due to premature posterior occlusion. It can be done as one-stage or two-stage procedure.

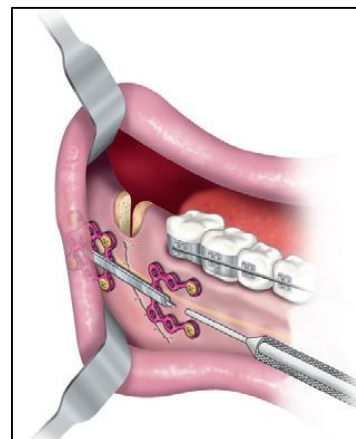
OTHER TECHNIQUES

Distraction osteogenesis: a relatively new surgical technique based on the principle of 'tension stress' that allows lengthening of bone and surrounding soft tissues through progressively controlled fracture separation by means of a distraction device. It was early used by Ilizarov in the 1950s to lengthen limbs. McCarthy et al. initiated osteo-distraction in the craniofacial skeleton in 1991, applying external distractor devices similar to those of Ilizarov to the mandible.

Indications: can be used for mandibular or maxillary lengthening and widening, ramus lengthening, and alveolar ridge augmentation (for preprosthetic purposes).

Advantages: no need for bone grafting, associated soft tissue lengthening, and diminished relapse.

Procedure: consists of 4 phases: *osteotomy* at the area to be lengthened, *latency period* without activation which usually takes 7 days after osteotomy, *activation period* in a rate of 1 mm per day, and *consolidation period* during which mature bone is formed between osteotomy ends.



POSTOPERATIVE CARE OF ORTHOGNATHIC SURGERY PATIENTS

As with any maxillofacial surgical patient, protection of the airway is the primary concern at extubation. In patients placed into wire/elastic IMF, the team should be prepared to remove the wires on an emergency basis if needed. Postoperative antibiotics and steroids are recommended during the first 24 hours. Detailed instructions are given to patients about their diet and oral hygiene. Postoperative orthodontic therapy with elastics or extraoral appliances may be required to treat 'immediate relapses' after releasing the IMF. Replacement of missing teeth and closure of created spaces after elongation procedures is achieved by fixed bridges or removable appliances.

COMPLICATIONS OF ORTHOGNATHIC SURGERY

Bad splits (inappropriate osteotomy), bleeding, neurosensory impairment in the mental or infraorbital distribution, condylar sag, proximal segment malpositioning, TMJ problems and condylar resorption, unesthetic scar (in extraoral approaches), nasal septal deviation, maxillary sinusitis, malunion and non-union, tooth damage, infection, bone necrosis, airway obstruction, speech changes, and relapse.