Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Baghdad
College of Dentistry

Orthognathic Mandibular Surgery

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Orthodotuc in Partial Fulfillment for the Bachelor of Dental Surgery

By
Yousif Munqth Ahmed

Supervised by:
Dr. Hala Mohammed Jasim
B.D.S, M.Sc (Orthodontics)

April, 2022

Certification of the Supervisor

I certify that this project entitled "Orthognathic mandibular surgery" was prepared by the fifth-year student “Yousif Munqth Ahmed” under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor’s name: **Dr. Hala Mohammed Jasim**

Date: 26/4/2021

Dedication

This work is dedicated to my family, my father and mother especially for all great support and for always believing in me.

I can never really thank you enough.

Acknowledgment

Special thanks to our Dean, the Dean of the college of Dentistry, University of Baghdad, **Prof. Dr. Raghad Al-Hashimi**, for upgrading the standards of our college.

My grateful thanks to **Assist. Prof. Dr. Yassir A. Yassir**, chairman of department of orthodontic at college of dentistry/University of Baghdad. Would like to express my deep gratitude to my supervisor **Dr. Hala Mohammed Jasim** for her scientific guidance, effort and support to finish this project.

Table of Contents

List of Figures

List Of Abbreviations	
Fig	Figure
FH	Frankfort Plane
BSSO	Bilateral Sagittal Split Osteotomy
BSSRO	Bilateral Sagittal Split Ramus Osteotomy
VSSO	Vertical Subsigmoid Osteotomy
RIF	Rigid Intraoral Fixation

Introduction

Orthognathic surgery may be defined as the surgical repositioning of the maxilla and/or mandible, and/or its segments, with or without orthodontic repositioning of the teeth, in order to correct dentofacial function, aesthetics and health. The term 'orthognathic' is derived from the Greek orthos: correct or straight, and gnathos: jaw.

Orthognathic surgery is a common method to treat dentofacial deformities, combined orthodontic and orthognathic surgical treatment is necessary to treat severe deformities where only orthodontics cannot give an acceptable result **(Naini, 2011).**

Orthognathic surgery is sometimes called "surgical orthodontics" because the treatment involves both orthodontics and surgery in most cases. Jaw growth is a gradual process, and in some instances, the upper and lower jaws may grow at different rates. The result can be a host of problems that can affect chewing function, speech, long-term oral health, and appearance. Injury to the jaw and birth defects can also affect jaw alignment. Orthognathic surgical procedures have been developed to reposition the jaws and have been traditionally used in the dentate patient to correct a skeletal malocclusion; these procedures are usually carried out with orthodontic control of the dentition to produce the best results **(Hosein, 2016)**. The majority of the clinical cases of the mandibular deformities can be solved by bilateral sagittal split osteotomy of the mandible (BSSO) and the horizontal sliding osteotomy of the mandibular symphysis (genioplasty), the BSSO and the genioplasty, described by Obwegeser in 1955 and in 1957, respectively, allows the surgeon to modify the mandible **(Obwegeser, 1964)**.

The main objective in orthognathic surgery is to achieve a stable, functional class I occlusion. However, this basic result, when straightening and aligning the jaws and teeth, can be achieved in any infinite vertical, sagittal, side-to-side, roll and yaw positions in space. For instance, a class I occlusion can be achieved, yet the jaws

still left deficient sagittally (with continued airway obstruction); or a class I with yaw or cant discrepancies can be present, which confers a significant and noticeable unaesthetic appearance. As such, the next-level objective in orthognathic surgery is to place the maxillomandibular unit not only in a class I, but in the most aesthetically optimized position in space **(Steinbacher, 2015)**

Aims of the Study

This review prepared to highlight the type of mandibular orthognathic surgery.

Chapter one (Review of Literature)

1.1. Patients Presenting For Orthognathic Surgery

Patients with dentofacial deformities are treated with four prime goals in mind:

1. Function: Apart from establishing normal masticatory function, the clinicians should also consider other problems caused by an abnormal jaw relationship such as speech defects, sleep apnea, attrition of the teeth, periodontal problems, and temporomandibular joint problems.

2. Stability of results: Definitive orthognathic treatment is a change for life, and it is important to achieve dental and skeletal stability following treatment.

3. Aesthetics: Facial appearance is often the patient's main concern, but patients are often reticent to voice these concerns. However, the surgeon should resist the temptation to determine unilaterally what a patient's aesthetic concerns are but should encourage the patient to express these concerns.

4. Airway: The impact of jaw malalignment (and its correction) on the patency of the upper airways is a relatively recent addition to the treatment considerations in patients with dentoskeletal malocclusion. The support of the retropharyngeal soft tissues is determined to a large degree by the position of the anterior osseous attachments. Inadequate support for these soft tissues will contribute greatly to the development of sleep apnea especially as soft tissue laxity develops with aging **(Hart *et al.*, 2015)**

1.1.1 Systematic Aesthetic Facial Evaluation

The clinical assessment of the face is the most valuable of all diagnostic procedures and should be performed in a systematic fashion. The facial examination should start at the first instant a clinician meets the patient and continues during the initial informal discussion. During this period the patient is not self-aware, and facial function and features will be at their most natural. The focused facial examination follows and should be done while the patient is seated comfortably in natural head

posture, the teeth in centric occlusion and the lips relaxed. The goal of the facial examination is to determine what components of the face are detracting from facial harmony and what functional problems may accompany the malocclusion **(Naini, 2011)**.

1.1.2 Frontal View

1.1.2.1 Facial proportions

The facial height is divided in three main third (Vertical relationships):

The upper facial third goes from the hairline to the glabella, the middle third from the glabella to subnasale, and the lower third from the subnasale to the underside of the chin. The lower third can be further divided so that the meeting point of the lips is one-third of the way from the base of the nose to the chin **(Naini *et al.*, 2017)**. **(Fig. 1)**

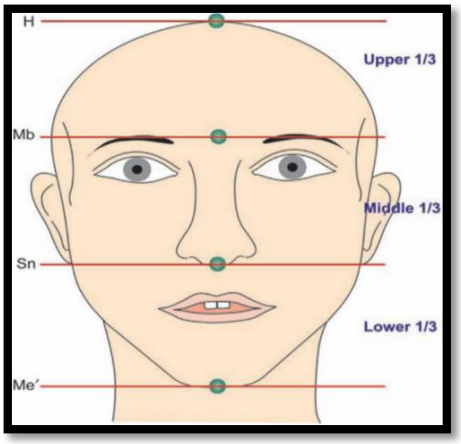

Fig. 1 Facial proportions

1.1.2.2 Facial Form

The relationship between the height and the width of the face has an important influence on facial form and harmony and should also be correlated with the patient's overall body build. The height-to-width proportions are 1.3:1 for females and 1.35:1 for males. The bigonial width should be approximately 30% less than the bizygomatic dimension and the width and shape of the chin should form a harmonious part of the overall facial contour **(Naini *et al.*, 2017). (Fig. 2)**

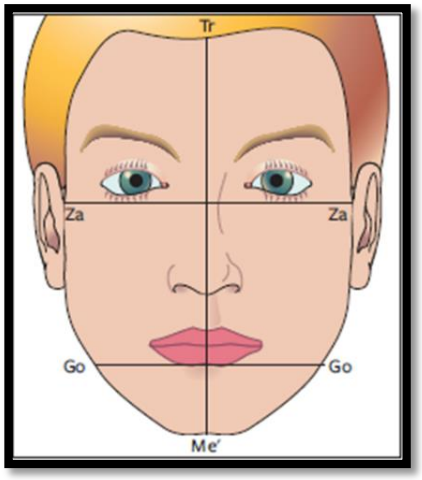

Fig. 2 Facial form

1.1.2.3 Facial Symmetry

The facial midline is the reference line to evaluate the forehead (glabella), nasal dorsum, nasal tip, maxillary dental midline, columella of the nose, philtrum of the upper lip, mandibular dental midline, lower lip, and the chin. During treatment planning the clinicians should assess if orthodontic or surgical correction of dental midlines is required. The face is a three-dimensional structure, and the symmetry of the face will be influenced by deformities in the vertical, anteroposterior, and transverse planes. Keep in mind that no face is perfectly symmetric **(Reyneke *et al.*, 2010)**. **(Fig. 3)**

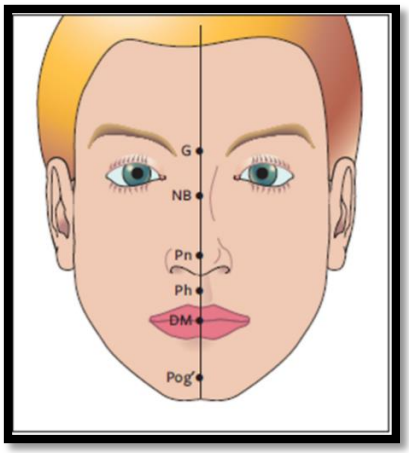

Fig. 3 The facial midline

1.1.3 Profile View

1.1.3.1 Nasolabial Angle

The nasolabial angle, which is measured between the inclination of the columella and the upper lip, should be in the range of 85 to 105 degrees. In females, a slightly larger angle is acceptable; whereas in males, a smaller angle is considered esthetically pleasing.

Patients with mandibular anteroposterior deficiency have increased nasolabial angles, and this angle is usually acute in individuals with Class III occlusion **(Reyneke *et al*., 2010). (Fig. 4)**

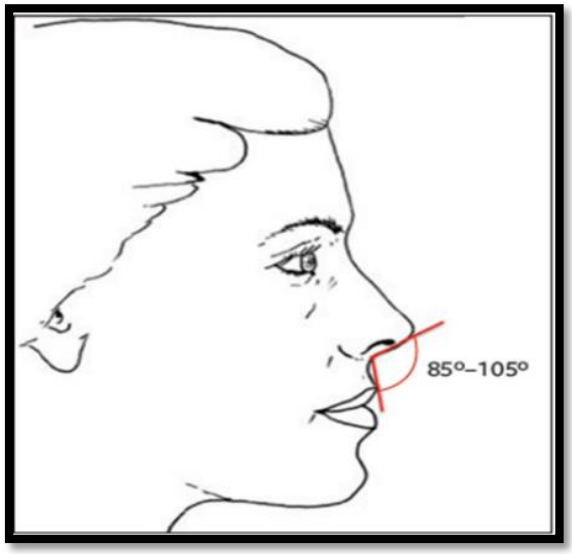

Fig. 4 Nasolabial angle

1.1.3.2 The Lip–Chin–Throat Angle

The angle is formed between the lower border of the chin and a line connecting the lower lip and soft tissue pogonion. The chin and submental area are considered attractive with an angle between 100° and 120° **(Reyneke *et al*., 2010)**. (Fig. 5)

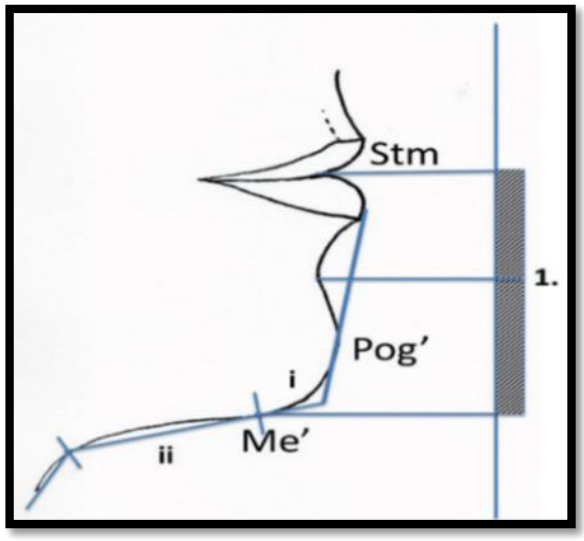

Fig. 5 The lip-chin-throat angle (i). Chin-throat length (ii)

1.1.3.3 Labiomental Angle

The mentolabial angle, also termed the labiomental angle, is a potentially important factor in the perception of facial profile attractiveness. It is the anterior angle formed by the intersection of a tangent to the lower lip and a tangent to the upper part of the soft tissue chin pad (mean = 120 ± 10°) (**Naini, 2011). (Fig. 6)**

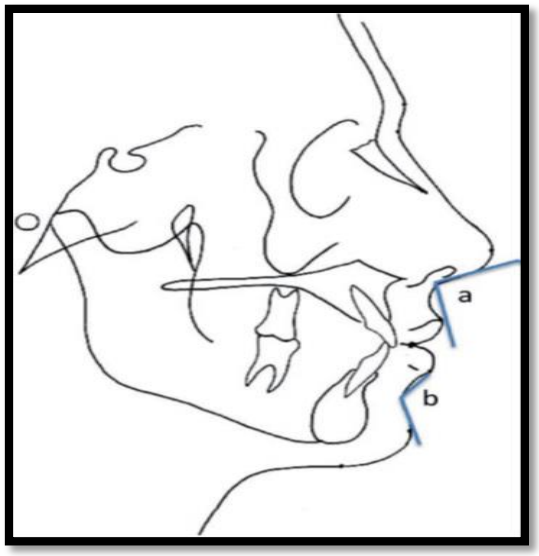

Fig. 6 (a) The nasolabial angle (b) Labiomental fold

1.1.4 Assessment of Anteroposterior Jaw Relationship

Ideally, maxillary skeletal base is 2-3 mm anterior to the mandibular skeletal base in centric occlusion. The sagittal skeletal relationship can be clinically assessed by two finger test. Clinical assessment of anteroposterior jaw relationship can be done by using the examiner's index and middle fingers placed approximately at point A and point B, respectively. Inference of the test: The sagittal skeletal relationship of the patient can be guessed by relative position of the two fingers.

• If the index finger is slightly ahead of middle finger— it indicates class II skeletal base pattern

•If the middle finger is ahead of the index finger—it indicates class III skeletal base pattern **(phulari, 2011).**

1.1.5 Radiographic Examination

A complete dental radiographic survey can be done with an orthopantomogram (OPG) to rule out a periapical or periodontal pathological condition.

The lateral cephalogram is essential for preoperative evaluation of all patients regardless of the type of deformity. In asymmetry cases, is most helpful in determining precisely the location of the deformity and in selecting the proper operative sites for surgical correction. Soft tissue outline on the cephalogram is marked by painting barium on the midline of the patient's face prior to shooting the radiograph. A combination of commonly used landmarks and measurements determine the degree and location of dentoskeletal deformity **(Singh, 2007).**

In addition to lateral cephalometric radiography, individuals with facial asymmetry require posteroanterior radiographic evaluation of the facial bones. It would certainly be advantageous to obtain a CBCT image or multislice CT to facilitate virtual treatment planning. CBCT allows images to be obtained with the patient in a standing or seated position with the teeth in the preferred occlusion and the soft tissue in repose **(Reyneke, 2021)**.

1.2. Surgical Anatomy of the Mandible

Mandible is the sturdiest bone of the face with strong basal bone and the alveolar part housing the dentition. The near round protuberances seen bilaterally at the cephalic end of the mandible are called condyles, and they form its articulation with the TMJ. Opening the mandible involves a complex series of movements, initial movement is rotational, which occurs in the lower TMJ compartment and a translational movement occurs in the upper TMJ compartment **(Norton et al., 2012)**. On the medial aspect of the vertical ramus is the mandibular foramen just posterior to halfway between the anterio-posterior width of the vertical ramus almost in line with the most concave part of the anterior border of the ramus. Just above is the lingula, a triangular prominence to which the sphenomandibular ligament is attached. Mandibular neurovascular bundle enters the mandibular foramen on the lingual side of the mandible and runs below the tooth roots in the body of the jaw, in the inferior alveolar canal. It curves upward and backward by about 2 mm and gives out the main branch, mental nerve, below the second premolar area, and gives sensory supply to the lower lip and chin **(Batra *et al*., 2010)**. **(Fig. 7)**

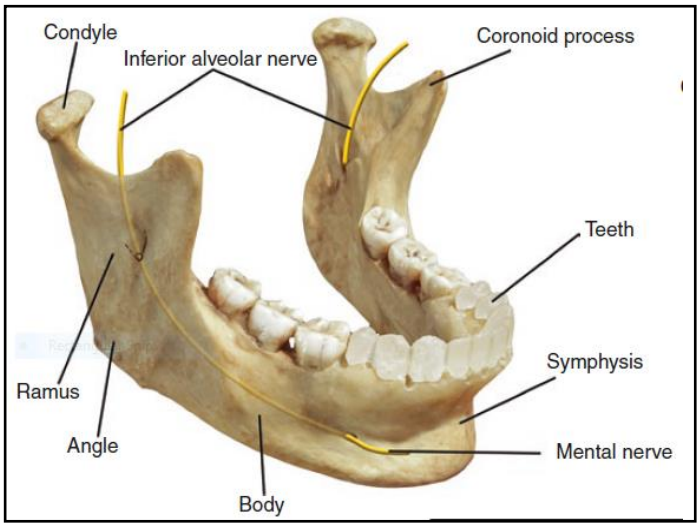

Fig. 7 Gross anatomy of mandible.

1.3 Classification of Deformities of the Mandible

Before venturing into the classification of the jaw deformities it will be appropriate to assess the relationship of the lower jaw to the rest of the face. Certain parameters are used to assess the deformity objectively. Clinical evaluation is the most important of them all. Face has to be assessed frontally and laterally.

Profile analysis of the face is the most important of them all—it could be convex, straight, or concave. Convexity can be due to protruded maxilla or retruded mandible/chin. Concave face can be due to retruded maxilla or prognathic mandible/chin **(Gateno *et al*., 2015) (Fig. 8)**.

a b c

Fig. 8 profile analysis of the face can be convex (a), straight (b), or concave (c)

Subnasale Perpendicular: Subnasale perpendicular is another important tool for assessing the profile. A line is drawn perpendicular to the Frankfort horizontal plane through the point Subnasale. This line is expected to go through the upper vermilion border, 2 mm anterior to the lower vermilion border and 4 mm anterior to the soft tissue Pogonion **(Fig. 9)**.

+/–2 mm is considered to be within normal limits **(Arnett *et al*., 1999)**

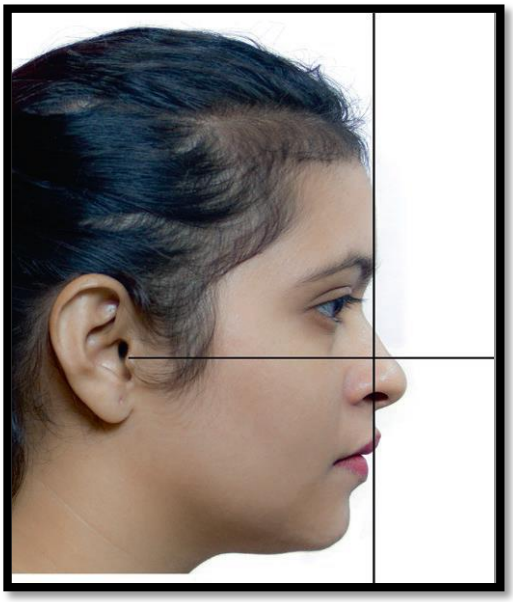

Fig. 9 Subnasale perpendicular to FH plane.

Nasion Perpendicular: This line is ahead by 5.3 ± 6.7 mm in males and 6.9 ± 4.3 mm in females. This indicates the position of mandible. Regarding the bony pogonion this line is ahead by 4.3 ± 8.5 mm in males and 6.5 ± 5.1 mm in females. This indicates the position of the chin. **(Arnett *et al*., 1999) (Fig. 10)**

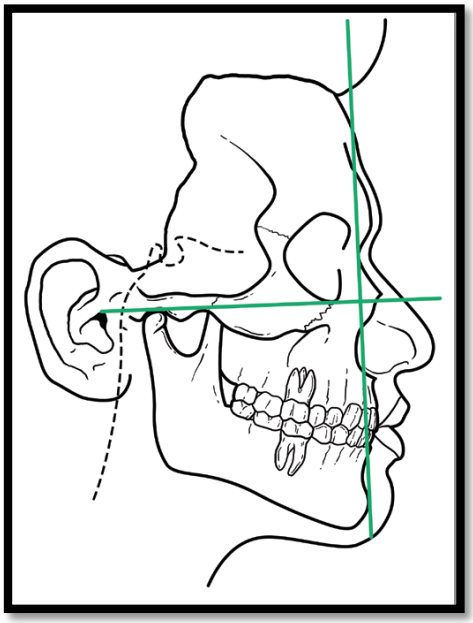

Fig. 10 Nasion perpendicular to FH plane

1.3.1 Mandibular Excess

Common cause for mandibular excess is either developmental or genetic. Very large mandible may be associated with acromegaly. **(Ayoub *et al*., 2013)**

The clinical features associated with mandibular excess are the following**:**

1. Prognathic mandible.
2. Anterior cross bite.
3. Elongated face.
4. Relatively long lower third of the face
5. Stomion-menton length—proportionately long.
6. Concave facial profile.
7. Lower lip and chin are more anteriorly placed than normal (SN perpendicular)
8. Class III relationship of occlusion.
9. Angle SNB—more than 82°.

1.3.2 Mandibular Deficiency

It is often due to genetical or developmental reasons. Ankylosis of temporomandibular joint, trauma to mandibular condyle and aplasia of condyle can also cause deficiency in mandibular growth. **(Ayoub et al., 2013)**

Clinical features associated with mandibular deficiency are the following:

1. Bird face appearance.
2. Severe over jet.
3. Class II relationship of dentition.
4. Crowding of lower anterior teeth.
5. Flaring compensation of lower anterior teeth.
6. Face appears small.
7. Lower third of the face is short.
8. Stomion-menton is proportionately short.
9. Labiomental fold is usually absent.

10. Chin neck angle is obtuse.

11. Angle SNB—less than 78°.

1.3.3 Deformities of Chin

The chin should be evaluated separately from the mandible. The chin prominence includes both bone and soft tissue that may require separate surgical management.

Deformities of chin could be three dimensional: vertical, anterio-posterior, or horizontal. Common abnormalities are **(Singh, 2007)**:

Macrogenia

The chin is too large in all dimensions. An anteriorly placed normal sized chin prominence (antegenia) will give a macrogenic appearance.

Microgenia

The chin is small in all dimensions. A normal sized chin, placed posteriorly (retrogenia) should be distinguished from microgenia.

1.3.4 Mandibular Asymmetry

The two halves of the base of the mandible have unequal dimensions; this may be seen in patients with hemimandibular hyperplasia, hemimandibular hypertrophy. Both halves of the base of the mandible may have equal dimensions but may be shifted to one side; this is called lateromandibulism **(Epker *et al*., 1998).**

1.4. Mandibular Osteotomy

1. Ramus Osteotomies.

a. Vertical Subsigmoid Osteotomy.

b. Sagittal Split Osteotomy.

2. Body Osteotomy of Mandible.

3. Symphyseal Osteotomy.

4. Lower Anterior Subapical Osteotomy.

5. Genioplasty.

6. Distraction Osteogenesis.

1.4.1 Ramus Osteotomies

Movement of the mandible in the anterior-posterior direction is usually achieved by ramus osteotomy.

The most commonly used ramus techniques are the following:

1.4.1.1 Vertical Subsigmoid Osteotomy

The vertical subsigmoid osteotomy **(Fig. 11)** is used primarily to move the mandible backwards for the correction of mandibular prognathism or asymmetry and involves a cut from the sigmoid notch in front of the condyle, extending vertically down behind the neurovascular bundle, to the angle of the mandible **(Cobourne and DiBiase, 2016)**.

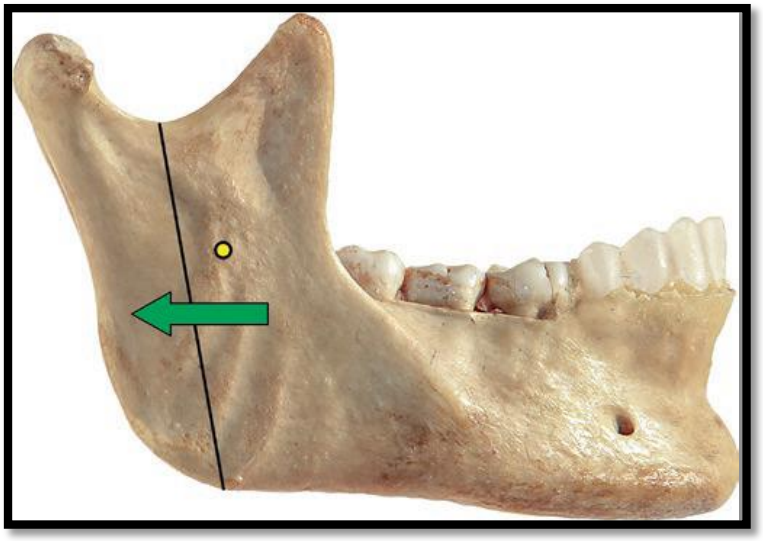

Fig. 11 Vertical subsigmoid osteotomy

In 1927 Wassmund described the inverted "L" osteotomy. Though the primary indication was mandibular prognathism, many surgeons advocated vertical osteotomy and certain modifications like inverted "L" osteotomy and "C" osteotomy for advancement of the mandible **(Caldwell *et al.*, 1968)**. Bone grafting has to be done to fill the gap created. **(Fig. 12)**

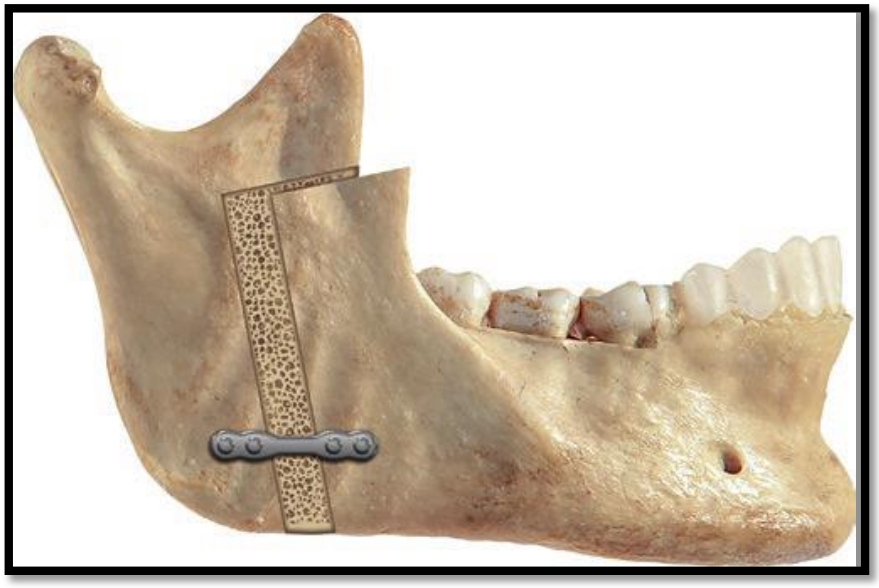

Fig. 12 Inverted "L" osteotomy of the ramus used for advancing the mandible

Complications

1. The most common operative complication of the VSSO is the poor direction of the saw position and fracture of the proximal segment across the posterior border of the mandible.
2. Displacement of the condylar segment medially and extensive bleeding have been reported among the operative complications of VSSO.
3. The most common immediate postoperative complication following VSSO is slight inferior displacement of the condylar segment which may require further surgical intervention to trim its inferior end.
4. Alteration of sensation of the lower lip has been documented following VSSO. **(Hosein, 2016)**

Fig. 13 Mandibular prognathism corrected by subsigmoid vertical osteotomy of the ramus on both sides to set back the mandible. (a, b) pre-op pictures, (c, d) post-op pictures

1.4.1.2 Sagittal Split Osteotomy

Sagittal split osteotomy (SSO) **(Fig. 14)** can be employed for correcting both retrognathism and prognathism.

Performing an inferior border osteotomy results in much lower incidence of persisting inferior border defects. Hence, during advancement of the mandible, it is advisable to exclude the lingual cortex in the split. Piezosurgery has been compared with conventional surgical drills/saws by several authors for BSSO. They have reported substantially longer surgery time for piezosurgery. Image-guided surgery has also become popular in the recent years, and this allows the surgeon to track the position of the instruments and segments during the operation in real time. Modern intraoperative navigation systems are being used in orthognathic surgery also **(Pietruski *et al.*, 2016)**.

a **b**

Fig. 14 Bilateral Sagittal Split Ramus Osteotomy (BSSO/BSSRO).

(a) Obwegeser split: Initially the medial cut in sagittal split osteotomy extended up to the posterior border, and when the distal segment was pushed back, the margin used to jut out, which had disadvantages like relapse tendency and injury to the retromandibular tissues. (b) Hunsuck split: At present the medial cut is taken above the mandibular foramen much short of the posterior border but behind the foramen. The complications are much less.

- Sagittal split osteotomy can be used for either mandibular advancement or setting back. If mandibular advancement is to be done, the medial pterygoid muscle is separated from the inferior border of the distal segment with a periosteal elevator. When the mandible is set back, medial pterygoid and masseter may have to be stripped, if needed, to prevent the displacement of the condylar segment posteriorly. Posterior stripping of the pterygomasseteric sling in SSO should be minimized to the antegonial notch. In excessive stripping, possibility for avascular necrosis increases **(Blair, 1906)**.
- Pushing the mandible backward reduces the space in the oral cavity. The tongue may not have enough space, and sometimes this induces tongue thrusting, snoring, etc. Some authors advocate reduction glossectomy to improve function related to airway speech and mastication. They also opine that reduction glossectomy improves aesthetics and controls unfavorable mandibular growth **(Wolford and Cottrell, 1996)**.

Complications:

Important complications associated with sagittal split osteotomy are **(Bonanthaya et al., 2021)**:

1. Bad split
2. Injury to the neurovascular bundle
3. TMJ problems
4. Excessive bleeding

The sagittal split osteotomy **(Fig. 15)** now is used for almost all mandibular surgery because of several advantages over alternative techniques for ramus surgery:

• The mandible can be moved forward or back as desired, and the tooth-bearing segment can be rotated down anteriorly (increasing the mandibular plane angle) when additional anterior face height is desired.

• This procedure is quite compatible with the use of rigid intraoral fixation (RIF), so immobilization of the jaws during healing is not required.

• Excellent bone-to-bone contact after the osteotomy means that problems with healing are minimized, and postsurgical stability is good. **(Proffit et al., 2018)**

Fig. 15 Bilateral sagittal split osteotomy to set back the mandible (a, b) pre-op pictures, (c, d) post-op pictures

1.4.2 Body Osteotomy of Mandible

This was one of the earlier procedures used for mandibular prognathism. Blair reported a body osteotomy at the premolar level for mandibular prognathism in 1906 **(Blair, 1906)**. Mandibular body ostectomy for correction of mandibular prognathism is often avoided due to complications such as inferior alveolar nerve injury and the development of other more reliable surgical procedures such as mandibular sagittal split ramus osteotomy (SSRO) **(Bell *et al*., 1980)**. However, this procedure still seems to be most effective in some cases, especially those with a large mandibular body. Furthermore, several methods combining mandibular body ostectomy with SSRO or vertical ramus osteotomy have been reported to yield good results **(Stoelinga and Leenen, 1992)**.

Body osteotomy at the molar level is almost outdated since the advent of sagittal split osteotomy. Body osteotomy anterior to the mental foramen can be resorted to in certain specific cases. The main indication of this procedure is lower dentoalveolar protrusion with anterior open bite. "V" osteotomy is done at the first premolar region **(Fig. 16)**. This will not reduce the total mandibular length but rotates the anterior segment upward and backward. Maintenance of the arch and occlusion is important. Rigid fixation is mandatory as tendency for relapse is very high due to the pull exerted by the genioglossus and geniohyoid muscles **(Bonanthaya et al., 2021)**.

Fig. 16 Body osteotomy at the level of the premolar region

1.4.3 Symphyseal Osteotomy

Midline osteotomy is used either to narrow or to expand the mandible. Expansion is more difficult than narrowing, due to tissue resistance. Before narrowing the mandible, a space must be created at the symphysis by extracting an anterior tooth **(Fig. 17)**. Parasymphyseal step osteotomy approach with a hybrid mode of force application might be the most viable option for true mandibular arch expansion **(Bonanthaya et al., 2021)**.

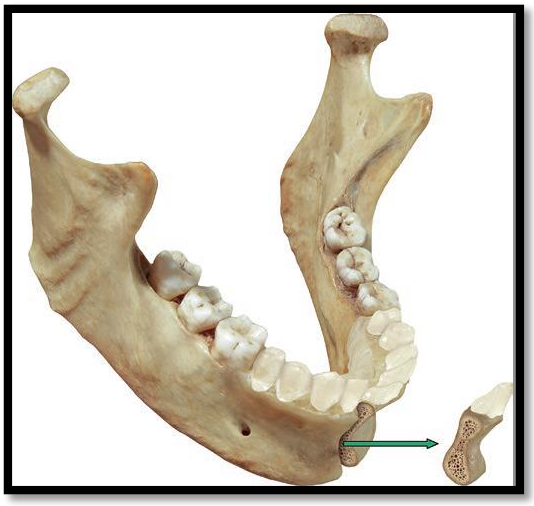

Fig. 17 Midline osteotomy

1.4.4 Lower Anterior Subapical Osteotomy

The anterior subapical osteotomy **(Fig. 18)** is occasionally used to alter the position of the lower labial segment in the mandible and requires vertical cuts through the alveolus behind the canine teeth, which are joined by a horizontal cut underneath the root apices to free the anterior segment.

Lower anterior subapical osteotomy is widely used in the following conditions **(Cobourne and DiBiase, 2016):**

1. To retrude the lower anterior dentoalveolar segment; often used in conjunction with subapical osteotomy in bimaxillary protrusion.
2. To close minimal anterior open bite.
3. To intrude the anterior segment in deep bite deformity.

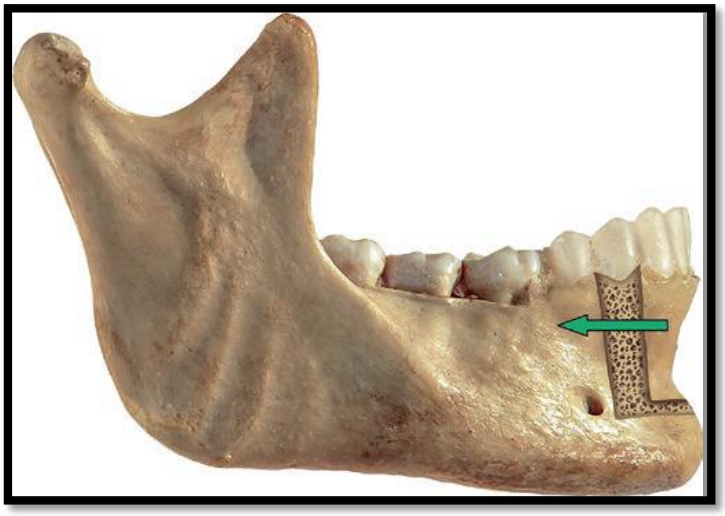

Fig. 18 Lower anterior subapical osteotomy

1.4.5 Genioplasty

The chin is a critical part of the face. A disharmony in the chin is very noticeable and should be corrected in an artistic way. Correction of a chin deficiency can be performed by reducing or augmenting in three different dimensions namely vertically, transversely, and sagittally **(Hosein, 2016).**

Fig. 19 Osteotomized chin can be moved in all the three dimensions

Bony cut is made on the chin about 4.5 mm below the apices of the teeth. The posterior end of the cut should taper to the inferior border, behind and below the mental foramen. (This prevents step defects at the site which may be manifested in the soft tissue also.) The segmented portion is freed from the rest of the mandible but remains pedicled to the digastric and geniohyoid. If the inferior segment is stripped off the periosteum, making it a free graft, intense inflammatory reaction and necrosis may occur. The degree of bone resorption and necrosis is indirectly proportional to the amount of pedicle attached to the segment **(Fitzpatrick BN, 1975)**.

Genioplasty can be used for widening and narrowing the chin in the horizontal direction. In mild mandibular asymmetry, the midpoint of the chin may be off the facial midline. By horizontal repositioning of the inferior border, the midpoint of the chin can be brought to the midline of the face, and the mandibular asymmetry can be camouflaged **(Bonanthaya et al., 2021)**. **(Fig. 20)**

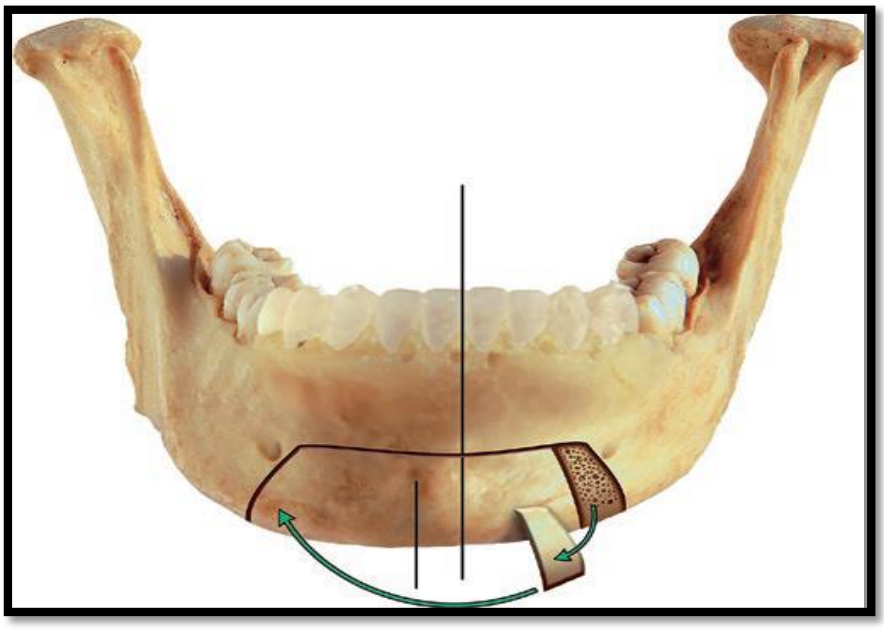

Fig. 20 Osteotomy plan for mild facial asymmetry pertaining to the chin

Complications

Although postoperative complications are infrequent, the following complications may occur **(Reyneke, 2021)**:

1- Damage to the mental nerve.

2- Damage to the roots of the canines and/or incisors.

3- Unexpected esthetic results due to excessive soft tissue stripping.

4- Postoperative hemorrhage and sublingual hematoma formation.

5- Wound dehiscence.

6- Unfavorable bone fracture.

1.4.6 Distraction Osteogenesis

Distraction osteogenesis is a recent introduction into the field of orthognathic surgery. This technique has revolutionized the possibilities of orthognathic surgery. The first team to report gradual distraction of human mandible was McCarthy et al. in 1992 **(McCarthy *et al.*, 1992)**. As bone has got regenerative capabilities, it is possible to create new bone and lengthen the bone in a cut segment by slowly distracting it. The technique is very useful in the management of deficiency of bone in the maxillofacial region as this is an excellent method to increase bone quantity. A new terminology "**distraction histogenesis**" has come into vogue as not only the bone but the surrounding tissues also get lengthened. Geniohyoid muscle can be lengthened to a maximum of 20% of its resting length **(Suhr and Kreusch, 2004).** It is possible to distract the inferior alveolar nerve as well **(Hu *et al.*, 2001)**. It is important that the distracted tissue is attached to vital tissue to maintain perfusion. After osteotomy a latency period of 4–7 days is advised to provide time for the soft tissue to heal.

Generally, DO in craniomaxillofacial region is indicated for superior bone lengthening, expansion or augmentation in which, conventional methods may have limitations. The direction of augmentation or expansion may vary from vertical,

anterior–posterior, transverse or multi-directional. In pediatric population, DO is used in obstructive sleep apnea resulting from midfacial retrusion or hypoplastic mandible. In adult patients with severe mandibular or maxillary deficiency in which correction cannot be achieved via conventional orthognathic surgery, DO is recommended. It is also used for correction of hemifacial microsomia and in bone transport technique, for example to reconstruct a hypoplastic or resected mandibular condyle. Distraction of atrophic alveolar ridges can be performed to increase the width or height of alveolar bone **(Yang, 2019)**.

In comparison, a conventional bilateral sagittal split osteotomy may allow up to 10 mm of jaw lengthening while up to 30 mm advancement could be achieved with DO subjected to the size of device **(Baur, 2021)**.

Four stages are recognized in distraction osteogenesis

a) Fibrovascular hematoma formation

b) Formation of collagen fibers parallel to distraction vector

c) Bone formation and remodeling of new bone

d) Formation of solid compact bone.

Chapter Two: Discussion

The main goals of orthognathic surgery are to achieve a correct bite, an aesthetic face, and an enlarged airway. While correcting the bite is important, if the face is not considered, the resulting bone changes might lead to an unaesthetic result. Patients with significant skeletal discrepancies and dentofacial deformities cannot be treated satisfactorily by orthodontic management alone. In such cases surgical correction by means of orthognathic surgeries of the mandible may be indicated to obtain optimal occlusal and esthetics results. Adult patients with significant skeletal malocclusion in whom growth modification procedures cannot be carried out may also benefit from orthognathic surgery. A team work approach consists of an orthodontist and maxillofacial surgeon is necessary to get the best result concerning the malformation. There are many type of mandibular orthognathic surgery, but the majority of the cases can be treated by sagittal split osteotomy and chin genioplasty.

Excessive bleeding is a major intraoperative risk associated with orthognathic surgery, the causes of massive bleeding in orthognathic surgery include injury to the facial artery, maxillary artery, inferior alveolar artery, sublingual artery, posterior mandibular vein, and pterygopalatine venous plexus in mandibular surgery.

Chapter Three: Conclusions and Suggestions

Mandible is a horse shoe-shaped bone hinged to the skull and performs the major function, chewing, and forms the lower part of the mouth which houses the tongue and other musculature. All the muscles of mastication and many other muscles of facial expression are attached to the mandible. Hence mandible is an important structure in both function and aesthetics. Different osteotomies of mandible can move the jaw in almost all the three directions and change the size and shape of the jaw and face to achieve better function and aesthetics.

Distraction techniques have established themselves as a highly efficient and practical mode of treating craniofacial defects. Newer techniques are making distraction osteogensis a routine procedure.

Suggestions

1. Preoperative photographs are necessary in order to have a record of pretreatment profile.

2. An orthopantomogram is necessary to rule out a periapical or periodontal pathological condition. A lateral cephalometric, anterio-posterior x-ray is also necessary in orthognathic surgery which allows for the assessment of the elements of the dentofacial skeleton.

3. Methods to control bleeding and avoid blood transfusion include:

   a) Proficiency in orthognathic surgical techniques to ensure safe and reliable surgery and shorten operative duration.
   b) Use of local anesthesia containing epinephrine and application of hypotensive anesthesia.
   c) Preparation of preoperative stored autologous blood.

References

A

1. Arnett, G. W., Jelic, J. S., Kim, J., Cummings, D. R., Beress, A., Worley Jr, C. M., Chung, B., Bergman, R. (1999) Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. *American Journal of Orthodontics and Dentofacial Orthopedics*, 116, 239–253.

2. Ayoub, A., Khambay, B., Benington, P., Green, L., Moos, K. and Walker, F. (2013) Handbook of Orthognathic Treatment - A team approach. *Handbook of Orthognathic Treatment: A team approach.*

B

3. Batra, A., Mahajan, A. and Gupta, K. (2010) Marginal mandibular branch of the facial nerve: An anatomical study. *Indian Journal of Plastic Surgery*, 43(1), p.60.

4. Bonanthaya, K., Panneerselvam, E., Manuel, S., Kumar, V. V., and Rai, A. (2021) *Oral and Maxillofacial Surgery for the Clinician*.

5. Bell, W. H., Proffitt, W. B. and White, R. P. (1980) Surgical Correction of Dentofacial Deformities. *W.B. Saunders Co., Philadelphia*, 115-123.

6. Blair, V. P. (1906) Report of a case of double resection for the correction of protrusion of the mandible. *Dental Cosmos*, 48, 817–820.

7. Baur, D., (2021) *Distraction Osteogenesis of the Mandible.*

C

8. Caldwell, J. B., Hayward J. R. and Lister R. L. (1968) Correction of mandibular retrognathia by vertical L osteotomy: a new technique. *Journal of Oral and Maxillofacial Surgery*, 26, 259–264.

9. Cobourne, M. and DiBiase, A. (2016) *Handbook of Orthodontics*.

E

10. Epker, B., Stell, J. and Fish, L. (1998*) Dentofacial deformities: integrated orthodontic and surgical correction.*

F

11. Fitzpatrick, B. (1975) Reconstruction of the chin in cosmetic surgery (genioplasty). *Oral Surgery, Oral Medicine, Oral Pathology*, 39, 522–535.

G

12. Gateno, J., Alfi, D., Xia, J. and Teichgraeber, J. (2015) A Geometric Classification of Jaw Deformities. *Journal of Oral and Maxillofacial Surgery*, 73(12), S26-S31.

H

13. Hart, P., McIntyre, B., Kadioglu, O., Currier, G., Sullivan, S., Li, J. and Shay, C. (2015) Postsurgical volumetric airway changes in 2-jaw orthognathic surgery patients. *American Journal of Orthodontics and Dentofacial Orthopedics*, 147(5), 536-546.

14. Hosein, M. (2016) A Textbook of Advanced Oral and Maxillofacial Surgery.

15. Hu, J., Tang, Z., Wang, D. and Buckley, M. (2001) Changes in the inferior alveolar nerve after mandibular lengthening with different rates of distraction. *Journal of Oral and Maxillofacial Surgery*, 108(5), 1103–1114.

M

16. McCarthy, J., Schreiber, J., Karp, N., Thorne, C. and Grayson, B. (1992) Lengthening the Human Mandible by Gradual Distraction. *Plastic and Reconstructive Surgery*, 89, 1-10.

17. Moore, M., Guzman-Stein, G., Proudman, T., Abbott, A., Netherway, D. and David, D. (1994) Mandibular Lengthening by Distraction for Airway Obstruction in Treacher-Collins Syndrome. *Journal of Craniofacial Surgery*, 5(1), 22-25.

N

18. Naini, F., B. (2011) Regional aesthetic analysis: mentolabial (labiomental) fold. In: *Facial aesthetics: concepts and clinical diagnosis*.

19. Naini, F., B., Gill, D., S., (2017) Patient evaluation and clinical diagnosis In: *Orthognathic surgery, principles, planning and practice*. p. 199–206.

20. Norton, N., Netter, F. and Machado, C. (2012) *Netter's head and neck anatomy for dentistry*.

O

21. Obwegeser, H. (1964). The indications for surgical correction of mandibular deformity by the sagittal splitting technique. *British Journal of Oral Surgery*, 2, 157-171.

P

22. Phulari, B.S. (2011) *Orthodontics Principles and Practice*.

23. Pietruski, P., Majak, M., Swiatek-Najwer, E., Popek, M., Szram, D., Zuk, M. and Jaworowski, J. (2016) Accuracy of experimental mandibular osteotomy using the image-guided sagittal saw. *International Journal of Oral and Maxillofacial Surgery*, 45(6), 793-800.

24. Proffit, W., Fields, H., Larson, B. and Sarver, D. (2018) *Contemporary orthodontics*.

R

25. Reyneke, J. (2021) Essentials of orthognathic surgery.

26. Reyneke, J. P., Ferretti, C. (2010) Diagnosis and treatment planning for orthognathic surgery: *Oral and maxillofacial surgery*. p. 1437–1449.

S

27. Singh, G. (2007) *Textbook of orthodontics*.

28. Steinbacher, D. (2015) Three-Dimensional Analysis and Surgical Planning in Craniomaxillofacial Surgery. *Journal of Oral and Maxillofacial Surgery*, 73(12), 40-56.

29. Stoelinga, P. and Leenen, R. (1992) Combined mandibular vertical ramus and body step osteotomies for correction of unusual skeletal and occlusal anomalies. *Journal of Cranio-Maxillofacial Surgery*, 20(6), 233-243.

30. Suhr, M. and Kreusch, T. (2004) Technical considerations in distraction osteogenesis. *International Journal of Oral and Maxillofacial Surgery*, 33(1), 89-94.

W

31. Wolford, L. and Cottrell, D. (1996) Diagnosis of macroglossia and indications for reduction glossectomy. *American Journal of Orthodontics and Dentofacial Orthopedics*, 110(2), 170-177.

Y

32. Yang, H. (2019) *Osteogenesis and Bone Regeneration*.