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Management of deeply impacted lower third molars

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

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وَقُل رَّبِّ زِدْنِـي عِلْـمًا (١١٤)

" سـورة طه "

Certification of the Supervisor

I certify that this project entitled “Management or assessments of deeply impacted lower third molars” was prepared by the fifth-year student Tawj Jamal under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor Degree in Dentistry.

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Committee Certification

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Acknowledgment

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Dedication

To the most precious thing in my life, **my family**.

To the greatest women in the world, **my dear mother**, the source of inspiration, kindness and happiness.

To the greatest man and first love, **my dear father**, who is the most important influence in my childhood, I am dedicating my project to his soul.

To **my friends and classmates**, I am so lucky to have them.

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Introduction

(William,1975) stated impacted tooth as one which is completely or partially unerupted and is positioned against another tooth, bone, or soft tissue so that its further eruption is unlikely.

Etiology may be multifactorial usually due to adjacent teeth, dense overlying bone or soft tissue, size of the mandible or maxilla with the resultant lack of space in the jaw, aberrant path of the eruption, abnormal positioning of tooth bud, or pathological lesions **(Ishihara et al., 2012).**

Classifications of impacted third molars allow us to determine the degree of impaction and determine the best methodology for the surgical procedure **(Jaroń and Trybek, 2021)**.

It is important to evaluate the difficulty of the extraction by physical examination, and additional investigations. because this will allow prediction of the duration of the procedure and appointment time with the patient. **(Eshghpour and Nejat, 2013)(Ishii et al., 2017)**. CBCT must be recommended as the only imaging modality in impaction assessment. It provides a three dimensional view to help in better treatment planning, anticipating possible complications post surgery. **(Abhinaya et al., 2020)**.

Due to the rising demand for impacted wisdom tooth surgery, the hard tissue laser surgery and piezosurgery can clear the future of impacted molar surgery, and these approaches are more efficient in reducing postoperative complications compared to the conventional surgeries**(Keyhan et al., 2019)**.

Finally, inexperience of the surgeon, the lingual split technique, and tight suturing have been shown to increase the risk of postoperative complications **(Benediktsdóttir et al.,2004)**.

Aim of the study: is to review and assess of the difficulties of removal of deep impacted lower third molar and manage the complication during and after removal.

Review of Literature

Review of Literatures

1. Mandible

The mandible is one of the largest bones of the skull and the only movable one. It is a double-jointed bone which articulates with the articular eminence of the zygomatic process of the paired temporal bones. This is made possible by several ligaments about the joints and the contractions of the muscles that act upon the mandible. Articulation at this joint permits the teeth of the mandible to interact with the teeth on the opposing tooth-bearing arch, the paired maxillae, and thus function in biting, mastication, and other actions **(Breeland *et al*., 2021)**.

The structure of the mandible is greatly influenced by the alveolar process the teeth. At birth the mandible is without teeth, and the alveolar process has not yet formed.In children the mandible bears the deciduous teeth. The alveolar process is still relatively poorly developed because the deciduous teeth are considerably smaller than the permanent teeth. In adults the mandible bears the permanent teeth, and the alveolar process is fully developed. In old age with resorption of the alveolar process, the mandible is edentulous **(Hiatt, 2020)**.

1.1 Structure and function

The mandible is made up of the following parts **(Eric, 2015)**:

1.1.1 Body

The body is the anterior portion of the mandible and is bound by two surfaces and two borders. The body ends and the rami begin on either side at the angle of the mandible, also known as the gonial angle.

- External surface: The external surface contains the mandibular symphysis at midline, detected as a subtle ridge in the adult. The inferior portion of the ridge divides and encloses a midline depression called the mental protuberance. The edges of the mental protuberance are elevated, forming the mental tubercle. Laterally to the ridge and below the incisive teeth is a depression known as the incisive fossa. Below the second premolar is the mental foramen, in which the mental nerve and vessels exit. The oblique line courses posteriorly from the mental tubercle to the anterior border of the ramus.
- Internal surface: The internal surface contains the median ridge at midline and mental spines, which are just lateral to the ridge. The mylohyoid line begins at midline and courses superiorly and posteriorly to the alveolar border.
- Alveolar border: The alveolar border, which is the superior border, contains the hollow cavities in which the lower sixteen teeth reside.
- Inferior border: The inferior border creates the lower jawline and contains a small groove in which the facial artery passes.

1.1.2 Ramus

The ramus contributes to the lateral portion of the mandible on either side. The coronoid process and condyloid process are located at the superior aspect of the ramus. The coronoid process is anterior and the condyloid process is posterior; the two are separated by the mandibular notch. The ramus is bound by two surfaces and four borders and contains two processes.

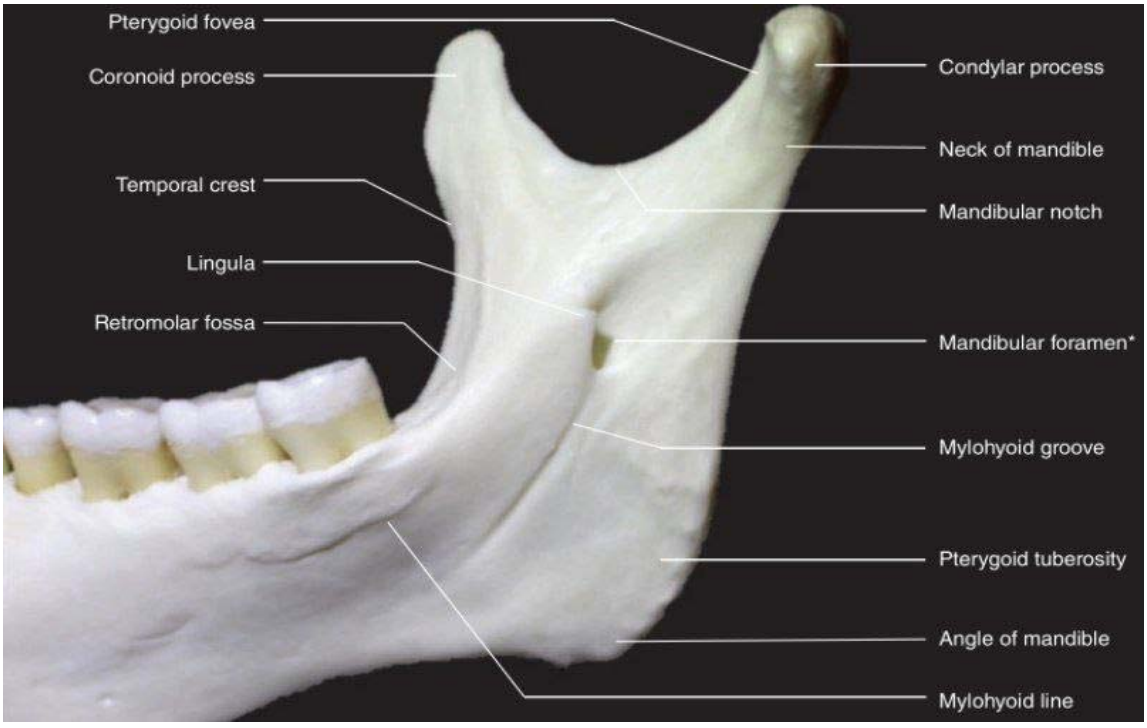
- Lateral surface: The lateral surface contains a portion of the oblique line, which began on the external surface of the body. This surface also provides the origin for the masseter muscle.
- Medial surface: The medial surface contains the mandibular foramen through which the inferior alveolar nerve and inferior alveolar artery enter and subsequent course the mandibular canal. At the anterosuperior aspect of the mandibular foramen is a sharp process called the lingula of the mandible. At the posteroinferior aspect of the mandibular foramen is the mylohyoid groove, against which the mylohyoid vessels run.
- Superior border: The superior border which gives rise to the coronoid and condyloid processes.
- Inferior border: The inferior border is continuous with the inferior border of the mandibular body and contributes to the jawline.
- Posterior border: The posterior border is continuous with the inferior border of the ramus and is deep to the parotid gland. This border is used in conjunction with the inferior border of the mandibular body to determine the gonial angle.
- Anterior border: The anterior border is continuous with the oblique line of the external surface of the body.

1.1.3 Coronoid Process

The coronoid process is located at the superior aspect of the ramus. Its anterior border is continuous with that of the ramus, and its posterior border creates the anterior boundary of the mandibular notch. The temporalis muscle and masseter insert on its lateral surface**(Eric, 2015)**.

1.1.4 Condyloid Process

The condyloid process is also located at the superior aspect of the ramus and is divided into two parts, the neck and the condyle. The neck is the thinner portion of the condyloid process that projects from the ramus. The condyle is the most superior portion and contributes to the temporomandibular junction by articulating with the articular disk**(Eric, 2015)**.

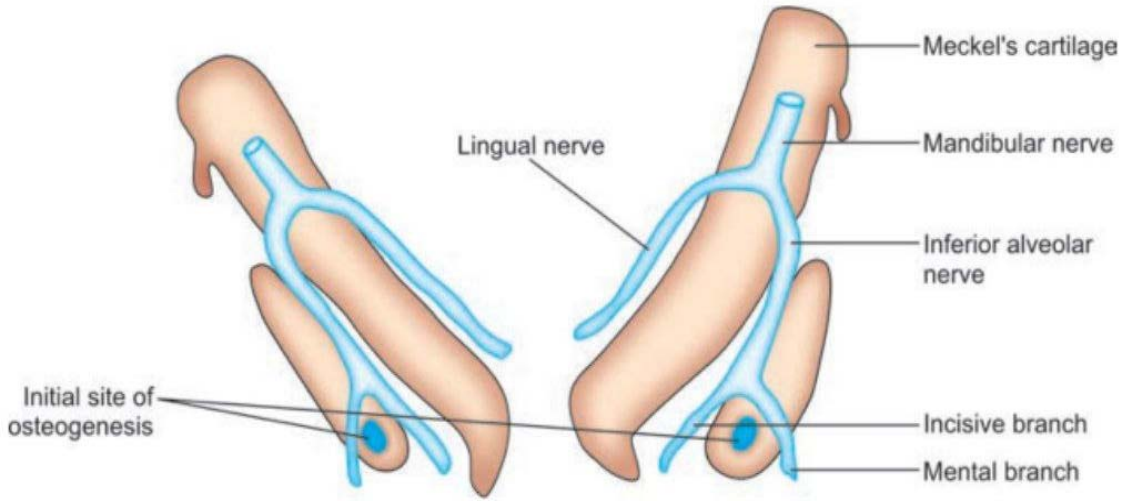


Figure(1): Medial view of the mandible**(Iwanaga and Tubbs, 2021).**

1.2 Embryology of The Mandible

Occurring during the sixth week of intrauterine development , The mandible is the second bone after the clavicle to ossify in the entire skeletal system**(Lipski et al, 2013) (Rajkumar and Ramya, 2017)**.

The first pharyngeal arch, known as the mandibular arch, gives rise to the Meckel cartilage.This cartilage serves as a template for the development of the mandible. A fibrous membrane covers the left and right Meckel cartilage at their ventral ends, each of which gives rise to a single ossification center. These two halves eventually fuse via fibrocartilage at the mandibular symphysis. Thus, at birth, the mandible is still composed of two separate bones. Ossification and fusion of the mandibular symphysis occur during the first year of life, resulting in a single bone. The remnant of the mandibular symphysis is a subtle ridge at the midline of the mandible**(Eric, 2015)**.



Figure(2) :Site of initial osteogenesis related to mandible formation**(Chatterjee, 2014)**.

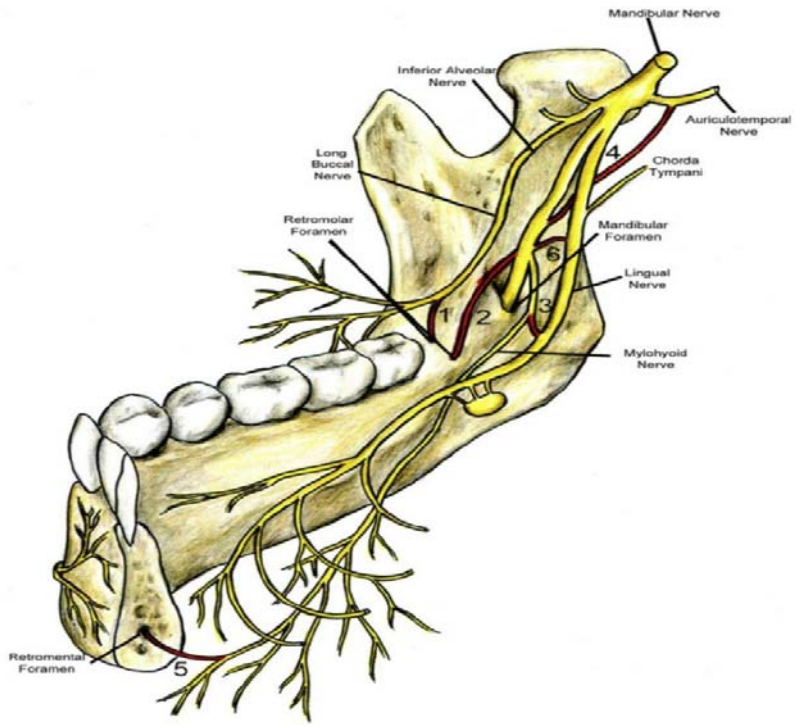
1.3Nerve and blood supply of mandible

1.3.1 Nerve supply of mandible

The inferior alveolar nerve, branch of mandibular nerve runs directly downward across the medial surface of the lateral pterygoid muscle. It is directed laterally and downward across the outer surface of the medial pterygoid muscle to reach the mandibular foramen. Just before entering the foramen, it releases the mylohyoid branch, a motor branch to the mylohyoid muscle and anterior belly of the digastric. The inferior alveolar nerve continues forward through the mandibular canal beneath the roots of the molar teeth to the level of the mental foramen. During thispart of its course, it gives off branches to the molar and premolar teeth, and their supporting bone and soft tissues. At the mental foramen, the nerve divides and a smaller incisive branch continues forward to supply the anterior teeth and bone and a larger mental branch emerges through the foramen to supply the skin of the lower lip and chin**(Chatterjee, 2014)**.

Other branches of the mandibular nerve contribute in some degree to the innervation of the mandible and its investing membranes. The buccal nerve, although chiefly distributed to the mucosa of the cheek, has a branch that is usually distributed to a small area of the buccal gingival in the first molar area, but in some cases, its distribution may extend from canine to the third molar. The lingual nerve, as it enters the floor of the

mouth, lies against the body of the mandible and has mucosal branches to a variable area of lingual mucosa and gingival **(Chatterjee, 2014)**.



Figure(3): The mandibular nerve and its branches **(Rodella *et al*., 2012)**.

1.3.2 Blood supply of the lower jaw and periodontium

The inferior alveolar artery, which supplies the mandibular teeth, is derived from the maxillary artery before it crosses the lateral pterygoid muscle in the infratemporal fossa. It descends on the medial aspect of ramus of the mandible to the mandibular before it passes through the mandibular foramen. It gives off a mylohyoid branch foramen to enter the mandibular canal. As it enters the mandibular canal it is accompanied by inferior alveolar nerve and at the level of first premolar tooth it bifurcates into incisive and mental branch. Posteriorly, the buccal gingiva is supplied by the buccal artery (branch ofmaxillary artery) as well

as branches from inferior alveolar artery. Anteriorly, the labial gingiva is supplied by the mental and incisive arteries **(Chatterjee, 2014)**.

1.3.3 Lymph supply of the lower Jaw

Lymphatic drainage of the mandible and mandibular teeth are primarily via the submandibular lymph nodes; however, the mandibular symphysis region drains into the submental lymph node, which subsequently drains into the submandibular nodes**(Eric, 2015)**.

2. Third molar

The last of the permanent teeth to appear are called third molar or wisdom teeth. The normal age of eruption of third molars is 18-25 years**(Passi et al., 2019)**. All third molars, mandibular and maxillary, show more variation in development than any of the other teeth in the mouth. Occasionally, they appear as anomalies bearing little or no resemblance to neighboring teeth**(Fuller, 1999)**.

2.1 Permanent mandibular third molar

The mandibular third molar occupies the eighth, and last, position from the midline in each mandibular quadrant. The mesial contact area is shared with the permanent second molar and there is no distal contact **(Rajkumar and Ramya, 2017)**.

Universal number:

Mandibular right third molar : #32

Mandibular left third molar : #17

2.2Crown and Roots form

Third molar crown formation begins around 9 to 10 years of age **(Vilela and Vitoi, 2011)**. The crown is wider at contact areas mesiodistally than at the cervix, the buccal cusps are short and rounded, and the crest of contour mesially and distally is located a little more than half the distance from the cervical line to the tips of the cusps. The type of third molar, which is more likely to be in fair alignment and in good occlusion with other teeth, is the four cusp type; this is smaller and shows two buccal cusps only from this aspect. The average third molar also shows two roots, one mesial and one distal. These roots are usually shorter, with a poorer development generally, than the roots of first or second molars, and their distal inclination in relation to the occlusal plane of the crown is greater. The roots may be separated with a definite point of bifurcation, or they may be fused for all or part of their length **(Nelson, 2015)**.

2.3 Unerupted or partially erupted teeth

Wisdom teeth often fail to erupt (unerupted tooth) or erupt only partially (partially erupted tooth). Unerupted or partially erupted teeth may be impacted, which means they are prevented from completely erupting into the normal functional position, due to a lack of space, obstruction by another tooth, or an abnormal path of eruption**(Hasan et al., 2021)**. Mandibular third molars (MTMs), or wisdom teeth, are the most frequently congenitally impacted teeth**(Kaya *et al.*, 2010)(Badawi *et al.*, 2004)**.

3.Impacted tooth

Tooth impaction is one of the most common abnormalities of tooth position . An impacted tooth is a tooth with a fully formed root, with complete development, which is partially or completely covered by hard and/or soft tissues, being outside the physiological period of eruption**(Peterson *et al.*,1998)**. An impacted tooth is a

tooth that fails to erupt into the proper functional location in oral cavity within the usual range of expected time**(Hupp *et al*, 2013) (Matsuyama *et al*.,2015)**.Lower third molar is the last tooth that erupts in the dentition, and it is the most frequently impacted tooth**(Hupp, 2014)**.The females have a higher incidence of mandibular third molar impaction when compared to males**(Juodzbalys and Daugela, 2013)**.While, Most studies have reported no gender predilection in third molar impaction**(Kaya *et al*., 2010)**.It is higher in the mandible than in the maxilla**(Hassan,2010)**.

Most mandibular third molars are impacted in the mandibular ramus area near the second molar, and the level of difficulty of extraction is classified according to the degree of impaction, position in the mandibular ramus, and angulation of the long axis of teeth. Usually, a third molar impacted far away from its original site is affected by a cyst or a tumor**(Lee *et al*., 2013)**.

3.1 Etiology

Wisdom teeth become impacted when there is not enough room in the jaws to allow for all of the teeth to erupt into the mouth. Because the wisdom teeth are the last to erupt, due to insufficient room in the jaws to accommodate more teeth, the wisdom teeth become stuck in the jaws, i.e., impacted. There is a genetic predisposition to tooth impaction. Genetics plays an important, albeit unpredictable role in dictating jaw and tooth size and tooth eruption potential of the teeth. Some also believe that there is a evolutionary decrease in jaw size due to softer modern diets.. All these factors existing alone or together adds to the condition of impacted third molar**(Narendar *et al*., 2019)**.

During normal development, the lower third molar begins in a horizontal angulation, and as the tooth develops and the jaw grows, the angulation changes from horizontal to mesioangular to vertical. Failure of rotation from the

mesioangular to the vertical direction is the most common cause of lower third molars becoming impacted, so that the mesiodistal dimension of teeth versus the length of the jaw is such that inadequate room exists in the alveolar process anterior to the anterior border of the mandibular ramus to allow the tooth to erupt into position **(Hupp *et al*., 2013)**.The gubernacular cord is a structure composed of the remnants of the dental lamina connects the tooth follicle to the overlying oral mucosa which guide or direct the course of the erupting tooth. Around the cord, a bony canal (gubernacular canal) develops and opens to the surface of the alveolar process.CBCT analysis showed that the absence of gubernacular canals led to a disturbance in the eruption and may contribute to the increasing risk of developing the condition of impacted third molar **(Koc *et al*., 2019).**

Many theories have been proposed owing to the causes of teeth impaction **(Malik, 2012)(Akinbami and Didia, 2010)**.

Theories of impaction by Durbeck **(Satwik and Naveed, 2014)**.

1) Orthodontic theory: Jaws develop in downward and forward direction. Growth of the jaw and movement of teeth occurs in forward direction, so any thing that interfere with such moment will cause an impaction (small jaw-decreased space). A dense bone decreases the movement of the teeth in forward direction.

2) Phylogenic theory: Nature tries to eliminate the disused organs i.e., use makes the organ develop better, disuse causes slow regression of organ. More-functional masticatory force – better the development of the jaw Due to changing nutritional habits of our civilization, use of large powerful jaws have been practically eliminated. Thus, over centuries the mandible and maxilla decreased in size leaving insufficient room for third molars.

3) Mendeliantheory: Heredity is most common cause. The hereditary transmission of small jaws and large teeth from parents to siblings. This may be important etiological factor in the occurrence of impaction.

4) Pathological theory: Chronic infections affecting an individual may bring the condensation of osseous tissue further preventing the growth and development of the jaws.

5) Endocrinal theory: Increase or decrease in growth hormone secretion may affect the size of the jaws.

3.2 Classification of the Impacted third molar

The classification carried out in this study may help in surgical planning so that it is possible to reduce the possibility of complications related to third molar extractions that can be trans-operative and postoperative**(Primo *et al*., 2017).**

3.2.1 Winter's classification

According to Winter's classification**(Winter,1926),** third molars are classified according to their inclination to the long axis of the second molar as following:

1) Mesioangular impaction
2) Distoangular impaction.
3) Vertical impaction.
4) Horizontal impaction.
5) Inverse impaction**(Wahab *et al*., 2022).**

Winter's lines arc three imaginary lines used to assess the difficulty of the extraction as mentioned by **(Malik, 2012)**.

White line: is drawn along the occlusal surfaces of the erupted mandibular molars and extended posteriorly over the third molar region. This line is used to assess the axial inclination of the impacted tooth as it becomes immediately apparent.

Amber line: is drawn from the surface of the bone lying distally to the third molar to the crest of the interdental septum between the first and second mandibular molars. It indicates the amount of alveolar bone enclosing the impacted tooth.

Red line: is used to measure the depth at which the impacted tooth lies within the mandible**(Kumar *et al*., 2014)**.

3.2.2 Pell and Gregory's classification

According to (Pell and Gregory) classification system, where the impacted teeth are assessed according to their relationship to the occlusal surface (OS) of the adjacent second molar, and the relation of the third mandibular molar to the ramus of mandible and second molar as following**(Alhadi *et al*., 2019):**

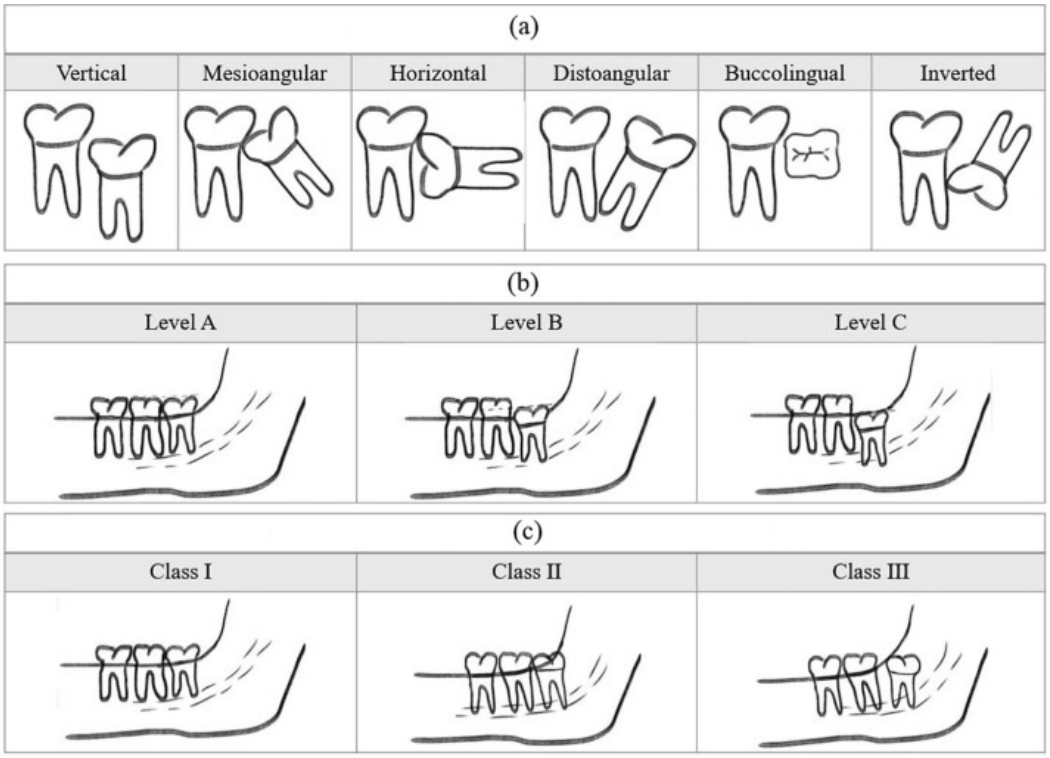
1) Relation of the tooth to ramus of mandible and second molar

- Class I: Sufficient amount of space for accommodation of the mesiodistal diameter of the crown of the third molar.
- Class II: The space between the ramus and distal side of second molar that is, less than the mesiodistal diameter of the third molar.
- Class III: All/most of the third molars is located within the ramus.

2) Relative depth of the third molar in the bone

- Position A: The highest portion of the tooth is on a level with/above the occlusal line
- Position B: The highest portion of the tooth is below the occlusal plane, but above the cervical line of the second molar

- Position C: The highest portion of the tooth below the cervical line of the second molar teeth in relation to the long axis of impacted second molar**(Santosh, 2015)**.



Figure(4):(a) The Winter classification for impacted third molar angulation. (b) The Pell and Gregory Classification of impacted third molar depth in relation to the cementoenamel junction of the second molar. (c) The Pell and Gregory Classification of impacted third molars in relation to the anterior border of the Ramus **(Alfadil and Almajed, 2020)**.

For the lower third molars, the prevalence was of mesioangular position (52.96 %), followed by the vertical position (39.14 %). Evaluating the depth, the predominant one was B (46.54 %), followed by A (39.63 %). The prevalence of the tooth relation to the mandibular ramus was class I (55.26 %), followed by class II (25.65 %)**(Primo *et al.*, 2017)**.wherefore the most common angulation was the

mesioangular angulation in the mandible.The most common level of impaction was the B level. There was no significant difference between the right and left sides in both jaws **(Hassan, 2010)**.

3.2.3 Depending on the degree of coverage by overlying tissue wisdom teeth are classified to (Latt *et al*., 2015):

1) Soft tissue impaction: when the tooth is covered only by soft tissue and its greatest bulge is above the level of the surrounding alveolar bone, the soft tissue can be dense and fibrous.

2) Hard tissue (bony) impaction: when the tooth is covered by bone and its lie greatest bulge is below the level of the surrounding alveolus. This can be mele partial or complete bony impaction. In partial bony impaction the height of the tooth's contour underneath the level of the surrounding alveolar bone and soft tissue cover the superficial part of the tooth. While in completely bony impaction the tooth is submerge completely inside the bone, so on reflection a flap no tooth can be seen.

3.2.4 Classification of the ectopic mandibular third molar

When the tooth is grossly displaced, for example up into the ramus or down below the level of the mandibular nerve, it may be referred to as ectopic **(Ahmed and Speculand, 2012)**. Ectopic positions include condyle ramus, coronoid process, sigmoid notch and lower border of angle of the mandible **(Apaydin and Salahattin, 2015)**.

(Wu *et al.*, 2017) described the classification of the ectopic lower third molar according to the imaginary lines drown as in (Figure 5):

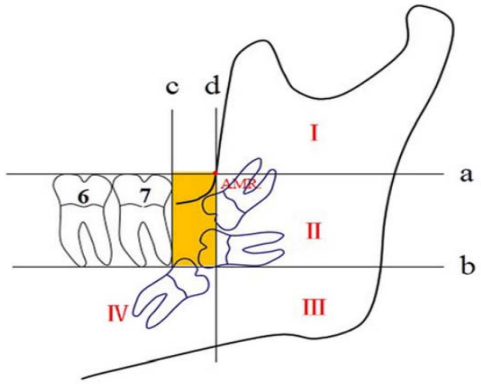
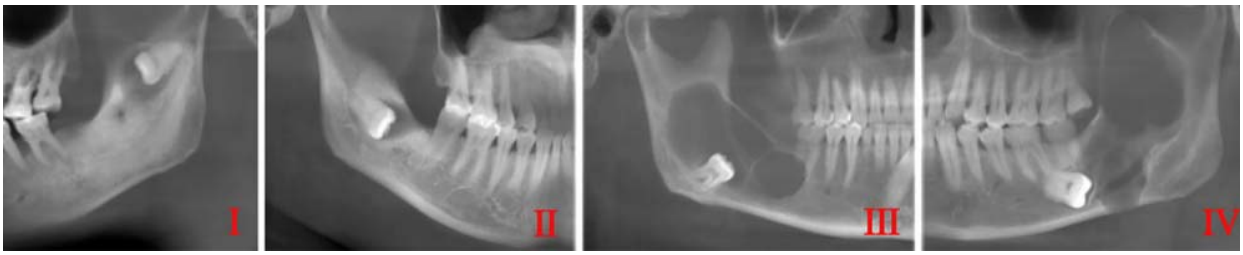


Figure (5): the line a: was drawn from the occlusal plane of the mesial teeth such as the second and/or first molar. The intersection point between the line a and anterior mandibular ramus was defined as AMR (anterior mandibular ramus). The line b: was extended from the root tips of the second molar or first molar when second molar was absent, which was also in parallel to the line a. The line c: was perpendicular to line a and tangential through the distant contour of the second molar. The line d: was through the AMR point and in parallel to the line c. Thus, the area surrounded by the four lines was defined as the physiological region for the third molar eruption. Accordingly, the mandible involved the ectopic third molar were further divided into four levels (I-IV) **(Wu *et al.*, 2017)**.

According to this imaginary lines as described before as shown at (Figure 5), The classification for ectopic divided into four levels (Figure 6):

- Level I upper ramus.
- Level II middle ramus.
- Level III mandibular angle.
- Level IV mandibular body.

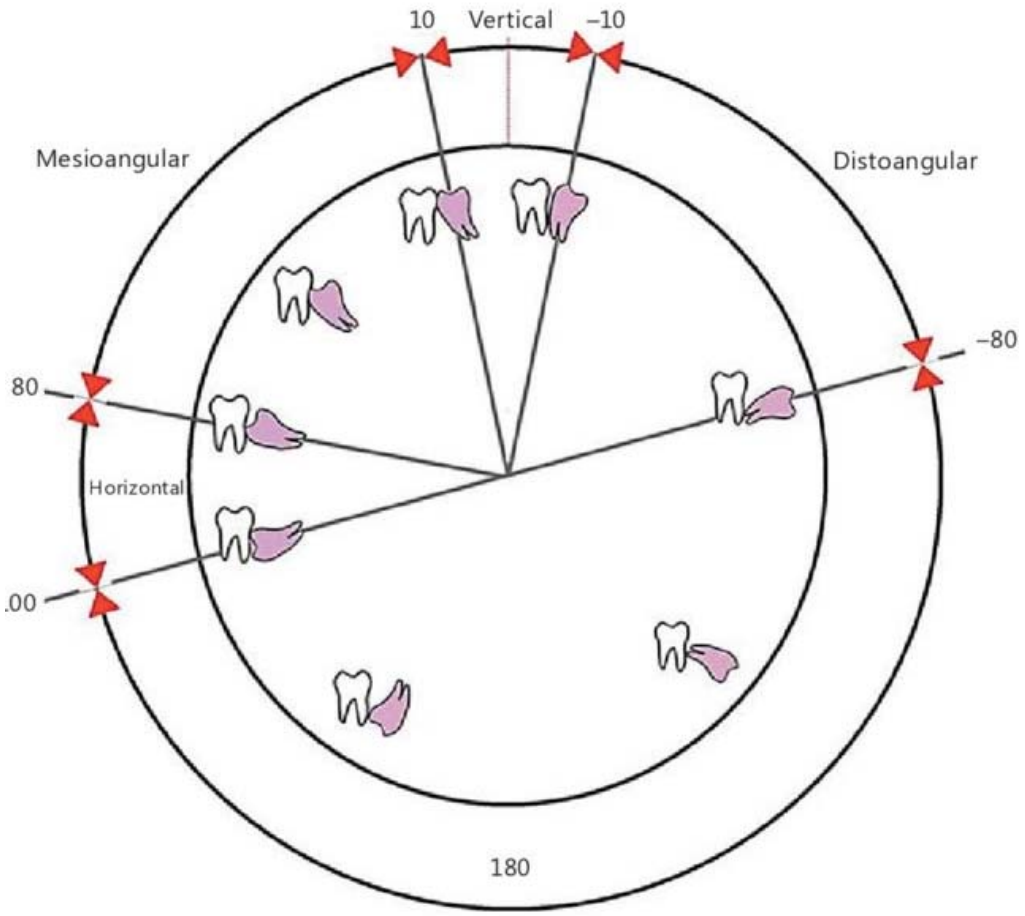


Figure(6):Classification of ectopic mandibular third molar based on panoramic images **(Wu *et al.*, 2017)**.

3.2.5 Other classification

Another system of measurement using an orthodontic protractor was incorporated to reduce errors arising from visual impression alone, was introduced by **(Quek *et al*., 2003)** in which the following classification was adopted for angulations, **(Latt *et al*., 2015)**(Figure7) :

1. Vertical angulation: 0° to 10˚
2. Mesioangular impaction: 11˚to 79°
3. Horizontal impaction:80°to 100˚
4. Distoangular impaction:-11°to -79°
5. Other:101°to -80°



Figure(7): Classification of angulation of impaction **(Latt *et al*., 2015).**

3.3 Indications for extraction of impacted mandibular Third Molars

The removal of impacted third molars is indicated for various therapeutic and prophylactic measures**(Mansuri *et al*., 2014)**. mandibular third molars cause various complications, surgical treatment is primarily performed to treat the symptoms associated with impaction **(Moghimi *et al*., 2013)(Sukegawan *et al*., 2019)**and prevent conditions that impair oral health**(Stanaitytė *et al*., 2014)**.The indications for extraction of impacted mandibular third molar are **(Hupp *et al*., 2013)**:

3.3.1 Periodontitis of lower second molar

Extraction of the impacted mandibular third molars significantly improved the periodontal status on the distal aspect of second molars, positively affecting the overall health of supporting periodontal tissues. Extraction of the impacted third molars early, periodontal disease can be prevented, If impacted teeth are left in the alveolar process, it is highly probable that one or more of several problems will result **(Blakey,2009).**

3.3.2 External root resorption

The impacted tooth causes sufficient pressure on the root of an adjacent tooth to cause external root resorption in such condition it will necessitated surgical removal **(Oenning *et al*., 2014)**.

3.3.3 Treatment of pain of unexplained origin

When a patient has Pain of Unexplained Origin, If conditions such as myofascial pain dysfunction syndrome and other facial pain disorders are excluded, and if the patient has an unerupted tooth, removal of the tooth sometimes results in resolution of the pain. In addition, delaying third molar removal to a later age may increase the chances of temporomandibular disorders **(Hupp *et al*., 2013)**.

3.3.4 Impacted Teeth Under a Dental Prosthesis

Impacted teeth should be removed before a prosthesis is constructed because if the impacted teeth must be removed after construction, the alveolar ridge may be so altered by the extraction that the prosthesis becomes less functional. In addition, if removal of impacted teeth in edentulous areas is achieved before the prosthesis is made, the patient is probably in good physical condition. Also, if implants are planned near the position of impacted teeth, removal is warranted to eliminate the risk of interference with the implantation procedure **(Hupp *et al*., 2013)**.

3.3.5 prevent Jaw Fractures

An impacted third molar in the mandible occupies space that is usually filled with bone. This weakens the mandible and renders the jaw more susceptible to fracture at the site of the impacted tooth **(Hupp *et al*., 2013)**.

3.3.6 Prevention of Odontogenic Cysts and Tumors

When impacted teeth are completely within the alveolar process, the associated follicular sac is also frequently retained, it may undergo cystic degeneration and become a dentigerous cyst. If the patient isclosely monitored, the dentist can diagnose the cyst before it reaches large proportions. However, unmonitored cysts can reach enormous sizes. If the follicular space around the crown of the tooth is greater than 3 mm, the preoperative diagnosis of a dentigerous cyst is reasonable. In the same way that odontogenic tumors can arise from the epithelium contained within the dental follicle around impacted teeth. The most common odontogenic tumor to occur in this region is the ameloblastoma **(Hupp *et al*., 2013)**.

3.3.7 Facilitation of Orthodontic Treatment

When patients require retraction of first and second molars by orthodontic techniques, the presence of impacted third molars may interfere with the treatment. Therefore it is recommended that impacted third molars be removed before orthodontic therapy is begun. Lower third molars influence on dental crowding is still controversial. Other factors which may cause mandibular incisors crowding could be divided into dental, skeletal and general. Wisdom teeth are only one of many factors that may cause crowding **(Stanaitytė *et al*.,2014)**

When the dentist makes the decision not to remove a tooth, the reasons must be weighed against potential future complications. In the case of younger patients who may suffer the sequelae of impacted teeth, it may be wise to remove the tooth while taking special measures to prevent damage to adjacent structures. However, in the case of the older patient with no signs of impending complications and for whom the probability of such complications is low, the impacted tooth should not be removed **(Hupp *et al*., 2013)**.

4. Assessment of the surgical difficulty for removal impacted third molar:

Preoperative assessment of surgical difficulty is fundamental to the planning of extraction of impacted third molars. The assessment is not only important to the dental surgeon who needs it to be able to decide whether or not to refer patients for specialist care, but it is also important in estimation the duration of the surgery and possible complications which might happens during or afterb the surgery that the patient should knows about it **(Gbotolorun *et al*., 2007)(Eshghpour and Nejat, 2013) (Ishii *et al*., 2017)**.

It is done by physical and radiographic evaluation. The physical evaluation includes the clinical variables that were statistically significant to intraoperative difficulty using Age, gender, inspection and palpation of the temporomandibular joint and movement of the mandible, determination of characteristics of lips and cheeks, size and contours of the tongue and appearance of soft tissue overlying the impacted teeth **(Juodzbalys and Daugela, 2013)**. Radiographic evaluation includes assessment of root morphology, size of follicular sac, density of the surrounding bone, contact with the second molar, nature of overlying tissues, inferior alveolar nerve and vessels, relationship to body and ramus of mandible, relation with adjacent teeth and buccal to lingual position of the third molar **(Khan *et al*.,2014)**. The radiologic factors are easily identifiable in either periapical x-rays or with orthopanthomographs or cone-beam CT **(Satwik and Naveed, 2014)**. The conventional radiographic views such as periapical, panoramic radiograph have been considered the first choice method **(Jhamb *et al*., 2009)**. however, where an over projection is observed between the third molar and the mandibular canal and when specific signs suggest a close contact between the molar and the canal, CBCT may be indicated that fills the lacunae of two dimensional imaging ,holds a key role in impaction assessment, display the examined volume in all anatomical planes, and the examiner is able to scroll through the sub-millimetre image slices, it assumed that more detailed information is offered than in 2D imaging **(Matzen and Wenzel, 2015)(Abhinaya *et al*., 2020) (Scarfe and Farman, 2014)**.

With the advent of cone beam computed tomography (CBCT), the errors produced in conventional radiography are eliminated and the excessive radiation exposure to patients who are subjected to medical CT could be reduced **(Kavarthapu and Thamaraiselvan, 2018)**. CBCT is advantageous as it has lower radiation dose, minimal metal artifacts, cost effective, easier accessibility than multislice CT

however, multislice CT is considered better for bone density analysis **(Baheerati and Don, 2019)**.

5. Management of deeply impacted lower third molar

Many investigators have questioned the necessity of removal impacted third molar for patients who are asymptomatic or have no associated pathologies, based on the view that retention of impacted teeth for a longer duration has less chances of pathological change in the tooth itself, or of deleterious effects on adjacent tooth and associated structures. Few authors have argued over the fact that all impacted third molars should be removed regardless of being asymptomatic, **(Mansuri *et al*., 2014)(Polat *et al*., 2008)(Mettes *et al*, 2012)**, while another group of authors considers that prophylactic surgical removal of impacted third molars is not necessary as the risk of development of pathological conditions in or around follicles of third molars is apparently low **(Adeyemo, 2006)**. There appears to be little justification for the removal of pathology free impacted third molars **(Song *et al*., 1997)**.

The surgical extraction of an impacted mandibular third molar is one of the most common procedures performed by oral and maxillofacial surgeons**(Lee *et al*., 2013) (Komerik *et al*., 2014) (Sammartino *et al*., 2017),** requires much planning and surgical skill, during both preoperative diagnosis and postoperative management.The treatment plans depend on the presenting complaint and the history of the patient, the physical evaluation, radiographic assessment, the diagnosis, and the prognosis. The management includes observation, exposure, transplantation or removal of the impacted tooth **(Gbotolorun *et al*., 2007)**.

5.1 Flap Design Techniques

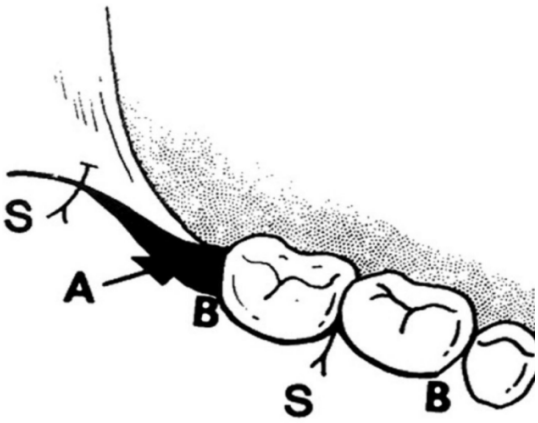
Several different flap techniques have been developed, compared, and discussed to minimize potential periodontal complications to adjacent second molar**(Karaca *et al*., 2007)** or improve surgical access **(Nageshwar, 2002)**.

5.1.1 Envelope flap

An envelope flap with the incision beginning just medial to the external oblique ridge and extending to the middle of the distal line angle of the second molar.From there, a sulcular incision was made from the distofacial line angle of the second molar to the mesiofacial line angle of the first molar. This flap could be modified to provide a gingivectomy of the tissues overlying the impacted third molar by extension of a second incision from the external oblique line to the distal edge of tissue.In the second flap"triangular flap" designed by Szmyd**(Szmyd, 1971)**, the first part of the incision was similar to the first.It was extended along the sulcus tothe distobuccal corner of the second molar crown. The incision was continuous, with a relieving vertical incision, oblique into the mandibular vestibular fornix, aligned with the mesiobuccal cusp of the second molar**(Yolcu and Acar,2015)**. Szmydrecommended the second modificationfor the following advantages : no need to detach the facial free gingival tissue around the second and first molar, decreased amount of reflected periosteum, broad-based blood supply to the flap, adequate exposure and visibility, good bony support for the soft tissue flap and closure can be effected with a single suture and the distal aspect of the third molar socket, As seen in (Figure 8,9).

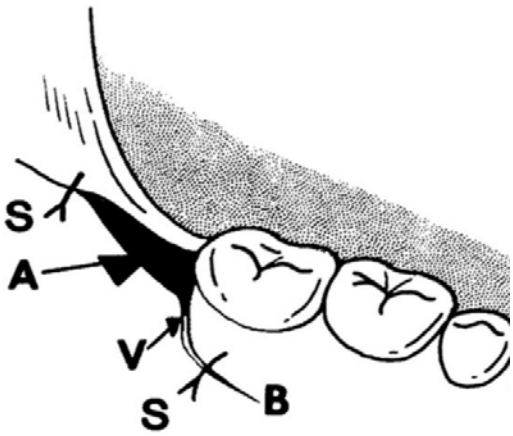
An envelope flap exposing the buccal bone of the adjacent second molar is the most common approach for lower third molar surgery **(Rosa *et al*.,2002)**.There are definite advantages of this flap design. The surgical site is adequately uncovered, providing generous visibility during the removal of the molar. The sulcular

incision can be extended mesially any time, if needed. As a consequence of the extensively prepared mucoperiosteal flap, the osseous defect can be safely covered after surgery. Moreover, blood supply up to the wound margins is adequate**(Jakse *et al.*,2002)**.however, possible disadvantages of this method are discussed. The distal extension of the incisions conventionally made to access impacted mandibular third molars comes close to or even cuts across the insertion of the temporalis tendon. It also commonly lies over the bone defect formed after removal of the tooth, This could be responsible, at least in part, for the occurrenceof trismus, pain, swelling, and periodontal damage of the preceding second molar after surgery **(Nageshwar, 2002)**.



Figure(8) : Envelope flap.

A: distal wedge of tissue to be removed,B-B: extent of sulcular incision, S:sutures **(Karaca et al., 2007)**.



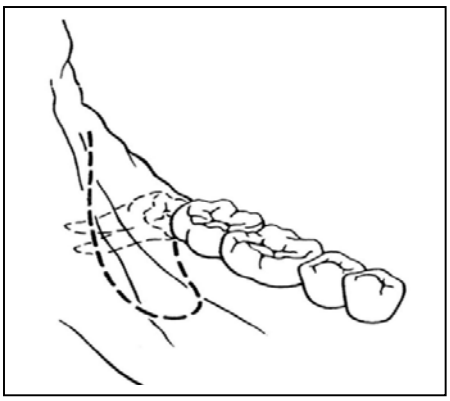
Figure(9) : Modification of the envelope flap.

A:distal wedge of tissue to be removed, V:vertical releasing incision to mucogingival line, B: anterior extent of horizontal releasing incision along mucogingival line, S:sutures**(Karaca et al., 2007).**

5.1.2 Vestibular tongue-shaped flap

Berwick, **(Berwick, 1966)** in 1966, designed a vestibular tongue-shaped flap that extended onto the buccal shelf of the mandible with an incision line that did not lie

over the bony defect created by the removal of the impacted tooth, and had its base at the distolingual aspect of the second molar to spare the periodontal ligament of the adjacent molar.



Figure(10) : Outline of incision of the vestibular tongue-shaped flap **(Berwick,1966).**

5.2 Surgical removal of the bone:

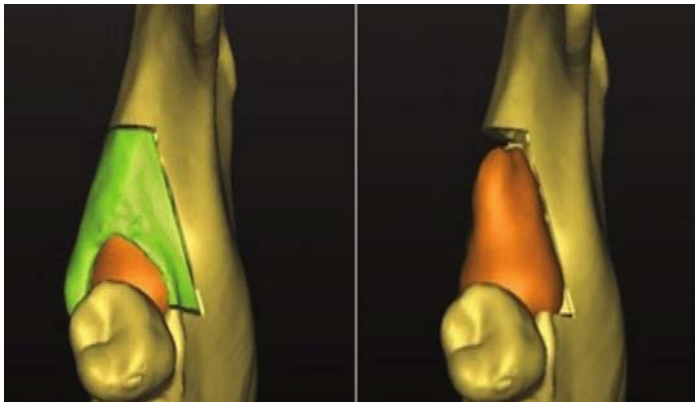
Bone covering the third molar was removed by:

1. The Lingual split technique using chisel and mallet.
2. The Buccal approach technique using chisel and mallet.
3. The Buccal approach technique using rotary instruments.
4. Saggital split osteotomy.
5. Laser.
6. Piezosurgery.

5.2.1 The lingual split technique using chisel and mallet :

This method describe by **(Ward, 1956)** First, a vertical stop cut was made distal to second molar using 3 mm chisel bevel end facing towards the second molar, which will prevent splitting of the bone along the buccal aspect of second molar, greater the depth of the wisdom tooth, longer the stop cut was made. After establishing the

point of elevation, the distal bone was removed to allow the delivery of the tooth. To remove this piece of bone, a 5 mm chisel was placed distal to the third molar with the beveled side upward and cutting edge parallel to the external oblique ridge. The chisel was driven to the depth required, which varies with the depth of the wisdom teeth and when desired level is reached, the chisel is removed and replaced with the beveled side down wards. Thus, the direction of the cut is altered from downwards to inwards towards the lingual plate without alteration in the direction of the chisel. When the bone is split, the chisel is twisted further and lingual plates breaks anteriorly at its thinnest point, this is where the crown of the third molar is nearest to the lingual surface. Then, the lingual splitted bone is removed, and the entire distolingual aspect of the impacted tooth is exposed.Lingual split technique using chisel and mallet is found to be better than other two groups**(Singh *et al*., 2013)**.



Figure(11): 3D reconstruction occlusal view showed the osteotomy line for lingual split technique **(Ge *et al*., 2016)**.

5.2.2. The buccal approach using chisel and mallet:

First, a vertical stop cut was made distal to second molar using 3 mm chisel bevel end facing towards the second molar, which will prevent splitting of the bone along the buccal aspect of second molar, greater the depth of the wisdom tooth,

longer the stop cut was made. After establishing the point of elevation, the distal bone was removed to allow the delivery of the tooth. To remove this piece of bone, a 5 mm chisel was placed distal to the third molar with the beveled side upward and cutting edge parallel to the external oblique ridge. In this case, lingual plate was not removed, but the point of application of elevator and direction of force of elevation is same as lingual split technique**(Vivek *et al.*, 2015)**.

Figure (12): Removal of Impacted mandibular third molar with chisel mallet technique **(Tiwari *et al.*,2019).**

5.2.3 The buccal approach technique using rotary instruments:

Rose head round bur/straight fissure bur were mounted on a low speed micrometer straight hand piece to remove the bone. A vertical cut was made using straight fissure bur with the same principal using saline as coolant. The point of application of elevation is same as other technique described.After removal of impacted third molar, wound was inspected carefully and checked for bone piece tooth follicles granulation tissues. Suturing was done by using 3-0 black silk. Same antibiotics and analgesic was given to all patients**(Singh *et al.*, 2013)**.

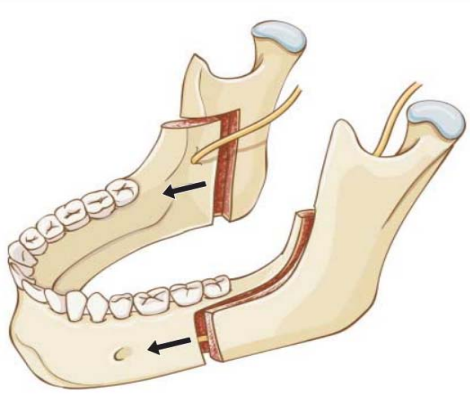
Figure(13):Removal of Impacted mandibular third molar with conventional rotary bur technique **(Tiwari *et al*.,2019).**

5.2.4 Saggital split osteotomy

Mandibular sagittal split osteotomy (SSO) is a feasible surgical technique for deeply impacted third molars removal. This technique allows excellent access for the impacted teeth in the middle of the ascending ramus, as well as pathology of the region **(Rubio, E.D. and Morumbo, M., 2019)**. Although primarily used for orthognathic surgery, may be indicated when a conventional operation requires extensive removal of alveolar bone **(Jones *et al*., 2004)**.

Removing the lower third molar by sagittal splitting of the mandible allows adequate access, controlled removal of bone, reduce the risk of pathological or iatrogenic jaw fracture in high risk cases, and enables the inferior alveolar nerve to be directly identified and protected **(O'Dwyer *et al*., 2019) (Jones *et al*., 2004)**.

Sagittal osteotomy is chiefly recommended in cases where the tooth is deeply impacted on the mandibular ramus or body, with its root communicating with inferior alveolar neurovascular bundles **(Sencimen *et al*., 2009)**.



Figure(14): Schematic illustration of mandibular ramus sagittal split osteotomy **(Saman *et al*., 2013)**.

Figure (15): The impacted molar is unearthed by sagittal split **(Sencimen *et al*.,2009)**.

5.2.5 Laser

During the past two decades, lasers have been widely used in many branches of medicine. Initially, CO2 lasers were used for cutting mineral tissues. Erbium-doped yttrium aluminum garnet (Er:YAG) lasers are solid-state lasers that emit light with a wavelength of 2940 nm. Due to its wavelength that is precisely fit with the optical absorption spectrum of water and also is absorbed by the hydroxyapatite, these lasers are an efficient device in cutting rigid structures like bone, so that after the cutting, they leave only a superficial layer of bone with a

size of a few micrometers**(Keyhan*et al*., 2019)**.The possibility of bone cutting using lasers is pursued, the osteotomy is easily performed and the technique is better suited to minimally invasive surgical procedures. The use of Er: YAG laser may be considered as an alternative tool to surgical bur, specially in anxious patients**(Passi *et al*., 2013).**

5.2.6 Piezosurgery

Piezosurgery is an osteotomy technique using micro vibrations at an ultrasonic frequency to perform efficient bone cutting.The philosophy of the development of bone surgery by piezoelectric technique is based on two fundamental concepts in bone surgery: the minimum invasiveness and predictability of the surgery. Ease of control of the device can reduce bleeding during the surgery, and accurate cutting and excellent tissue healing are promising in the optimistic results of surgery, even in some cases with anatomical complexity**(Galié *et al*., 2015)**.In operations performed with piezosurgery, there is no need to apply extra force to overcome the reverse force caused by micro-motor rotation, and the force required for cutting is much lower; in addition to keeping the same depth of the cut, it also provides a better control for the surgeon and exerts less trauma to the mineralized tissues using the principles of biomechanics, as well as prevents excessive heat. It also causes minimal tissue damage to the bone by maintaining the life of osteocyte cells, resulting in reduced swelling and pain after surgery and experiencing shorter treatment course by the patient **(Rahnama *et al*.,2013)**.

The major advantages of this technology include high precision, a design that increases ease of curvilinear osteotomy, less trauma to soft tissue, preservation of neurological and vascular structures, reduced hemorrhage, minimal thermal damage to the bone, as well as overall improvement of healing**(Hennet,2015)**.

Figure(16) : Piezosurgery device with handpiece, footswitch and different inserts. The main unit contains a peristaltic pump for cooling with a jet of physiological saline solution and a control panel with a digital display to select the different modes and power levels**(Grauvogel *et al.*, 2011).**

5.3 Removal of deeply impacted third molar :

The operation used to remove the third molar was classified as nonsurgical, surgical, soft tissue impaction, partial bony impaction, and full bony impaction. These operative terms were defined as follows**(Bui *et al.*,2003):**

1) Nonsurgical: an erupted tooth removed with forceps and elevators only, not requiring incision of soft tissue or elevation of a flap.

2) surgical: an erupted tooth removed that required incision of overlying soft tissue, elevation of a flap or requiring removal of bone or the sectioning of a tooth using a surgical drill or chisels.

3) soft tissue: an impacted tooth removed requiring incision of overlying soft tissues and elevation of a flap and the use of forceps or elevators.

4) partial bony: an impacted tooth removed in a manner similar to soft tissue, but requires bone removal to facilitate extraction.

5) full bony: an impacted tooth removed by the same technique as a partial bone impaction, but requires sectioning of the tooth in addition to bone removal to facilitate extraction. The anesthetic technique was classified as local anesthesia alone or general anesthesia. Patients having general anesthesia were hospitalized and intubated for the procedure.

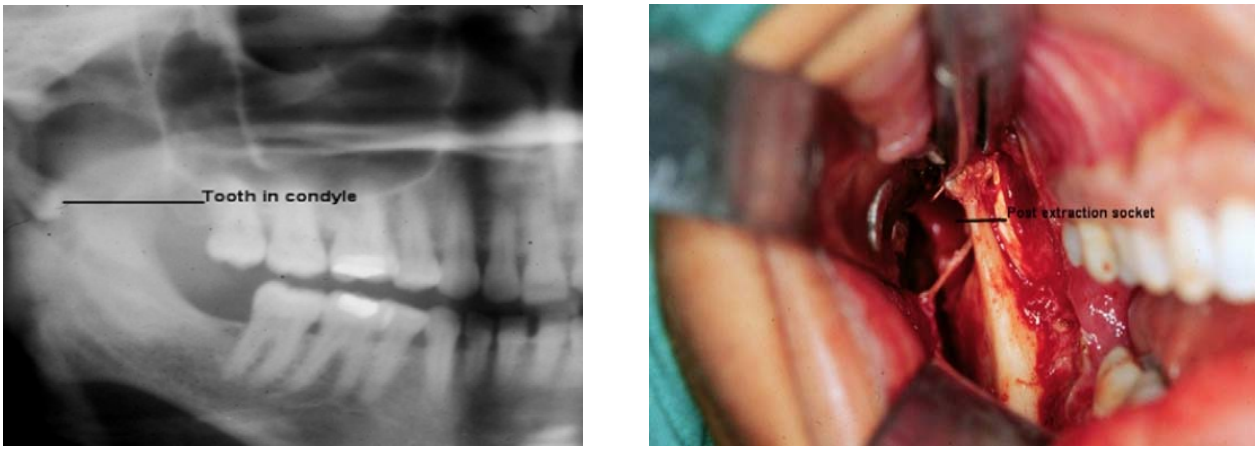
Ectopic third molar teeth are often an incidental finding on a routine radiograph and no treatment is required unless they are symptomatic or have associated pathology **(Wu *et al*., 2017).** The cause of their malposition is unclear although many theories have been put forward. During mandibular development as the ramus elongates and grows upward, it may take the tooth germ with it. The majority of ectopic mandibular third molars are associated with the development of cystic lesions or tumor that may push the tooth into an abnormal position . Other proposed causes include a lack of space between the second molar and ramus of the mandible, trauma and aberrant eruption **(Ahmed and Speculand, 2012)**.

Ectopic mandibular third molars are usually found in patients with middle ages and in upper and middle ramus of mandible **(Wu *et al*., 2017)**. To determine the precise locations for these ectopic mandibular third molars, various diagnostic images were used. Panoramic radiograph is generally sufficient for making the diagnosis of an ectopic third molar **(Adachi *et al*., 2015)(Findik and Baykul, 2015)**. Three-dimensional anatomical position of ectopic mandibular third molar and its relation to surrounding anatomical structures can be evaluated with CT or CBCT **(Bortoluzzi and Manfro, 2010)**.

Therapeutic options are based on the clinical presentations, surgical risks and complications as well as patient preference **(Iglesias *et al*., 2012)**. If the tooth is asymptomatic, it can be closely monitored with regular follow-up. Surgical intervention is indicated when the tooth is associated with pathological lesion or it

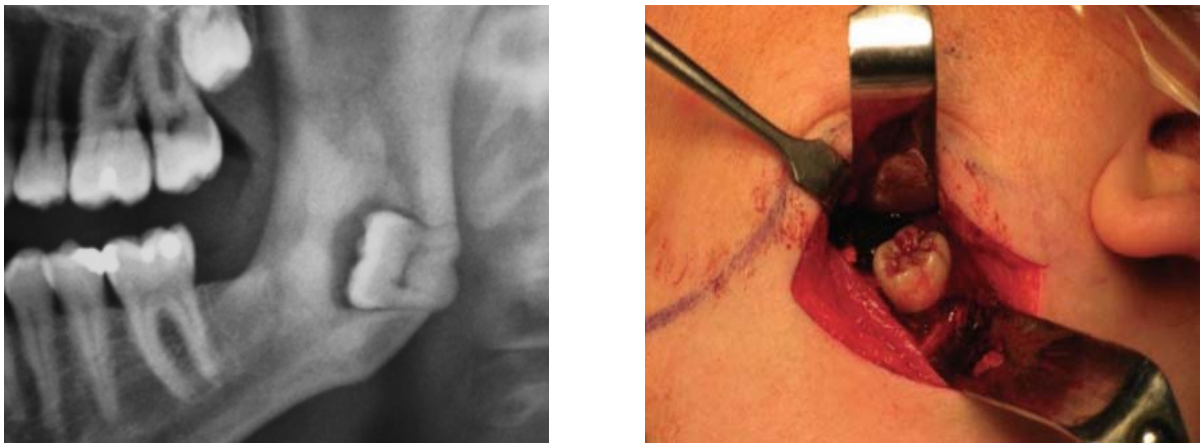
cause discomfort and clinical symptoms. The intraoral approach is preferred as a routine technique and considered to be more conservative, although it has the limitation of inadequate visualization and lack of surgical fields **(Ahmed and Speculand, 2012)**. When decided to remove the third molar in the region of the condyle surgically via an intra-oral approach, the incision was made intra-orally along the external oblique ridge and anterior border of ramus of mandible, short of the coronoid notch, taking care to avoid injury to the parotid duct, as seen in the case that is shown in figure (16). The bone was to be perforated on the anterolateral aspect, this perforation was enlarged using the handpiece and long round ENT burs. The long shaft cryer elevator was used to elevate the tooth gently laterally while the final retrieval was carried out using long heavy artery forceps. The associated cyst was removed and the wound irrigated copiously with saline and povidone iodine solution. Satisfactory haemostasis was achieved in 10 min with a gauze pack soaked in povidone iodine. 4-0 Vicryl (NW 2443) was used to close the wound under suction drainage **(Gadre and Waknis, 2010)**.

The extraoral approach is selected to get access to the tooth directly but with the possibility to damage the facial nerve and leave facial cutaneous scar **(Bowman *et al*.,2014)(Laino *et al*., 2015)**. For example, Figure (17) It involves incising through skin and superficial fascia and platysma and exposing the superficial surface of the masseter muscle. After checking for the position of the branches of the facial nerve, the muscle is incised horizontally to expose the mandible. The ectopic tooth is exposed and removed and the wound is then closed in layers(**Ahmed and Speculand, 2012)**.



A B

Figure(17): A- Ectopic mandibular third molar in the region of the right condyle. B- Intra operative photograph showing the post-extraction socket **(Gadre and Waknis, 2010)**.



A B

Figure (18): A- Ectopic mandibular third molar at the posterior border of the angle of the mandible. B- Extra-oral approach**(Ahmed and Speculand, 2012)**.

5.4 Preparing for Wound Closure

A bone file is used to smooth any sharp, rough edges of bone, particularly where an elevator was in bony contact. The surgeon should next direct attention to removing all particulate bone chips and debris from the wound. This is done with vigorous irrigation with sterile saline. Special care should be taken to irrigate thoroughly under the reflected soft tissue flap. A small hemostat can be used to remove any remnants of the dental follicle, if present. Once the follicle is grasped, it is lifted with a slow, steady pressure, and it will pull free from the surrounding hard and soft tissues. A final irrigation and a thorough inspection should be performed before the wound is closed. The surgeon should check for adequate hemostasis. The closure of the incision made for an impacted third molar is usually a primary closure. If the flap was well designed and not traumatized during the surgical procedure, it will fit into its original position. The initial suture should be placed through the attached tissue on the posterior aspect of the second molar. Additional sutures are placed posteriorly from that position and anteriorly through the papilla on the mesial side of the second molar. Usually, only two or three sutures are necessary to close an envelope incision. If a releasing incision was used, attention must be directed to closing that portion of the incision as well **(Huppetal.,2013)**.

6. Complication of the removal lower third molar

Complications associated with the removal of impacted teeth are relevant and is aided bytooth-related factors linked to postoperative complications such as mesio-horizonal position of the tooth, deep impaction, and pericoronitis. In addition, patient related factors such as older age, female gender, and use of oral contraceptives and tobacco have caused an increased risk of postoperative complications**(Benediktsdóttir *et al*.,2004)**.

During surgery, bone removal and tooth sectioning were considered as risk factors of complications of the removal of the third molars **(Barbosa-Rebellato *et al*., 2011).** As bony impactions require lengthier procedures involving bone removal and a wider flap reflection, there was a greater chance for damaging adjacent structures**(Blum, 2002)**. Most patients will experience pain and swelling after surgery (worst on the first postoperative day) then return to work after 2 to 3 days with the rate of discomfort decreased to about 25% by post-operative day. unless affected by dry socket a disorder of wound healing that prolongs postoperative pain. Long-term complications can include periodontal complications such as bone loss on the distal aspect of second molar following wisdom teeth removal. Which is uncommon in the young but present in 43% of those of 25 years of age or older.

According to the study done by **(Ayaz, 2012)** the most common postoperative complications were swelling (92.5%), pain(88.6%) and trismus(81.1%) followed by nerve injury(6.6%), dry socket(3.8%) and infection(2.8%). Initiation or worsening of temporomandibular joint problems is uncommon and unpredictable**(Juodzbalys and Daugela, 2013)**.

6.1 Swelling / postoperative edema

Postsurgical edema is an expected complication after third molar surgery. It can be caused by the response of the tissues to manipulation and trauma caused during surgery. Its onset is gradual and maximum swelling is present during 48 h after surgery **(Deliverska and Petkova, 2016)(Santos *et al.*, 2020)**. The application of ice (3 - 4 h) to the extraoral site of surgery that reduced temperatures cause vasoconstriction and reduces postoperative swelling **(Cho *et al.*, 2017)**. However, The application of ice for too long can also be harmful. Tissue death can result due to prolonged vasoconstriction, ischaemia and capillary thrombosis **(Cheung *et al.*, 2015)**.haemostatic sponge appeared to be an effective and safe to relieve postoperative swelling**(Refahi *et al.*, 2021)**.

6.2 Hemorrhage

Hemorrhage might happen during (accident) or after (complication) the surgery. Anatomical variations, tooth proximity to the vascular nerve bundle of the mandibular canal, and coagulopathy are the main causes of hemorrhage **(Deliverska and Petkova, 2016) (Azenha *et al.*,2014)**. Local factors that result from soft tissue and vessel injury represent the most common cause of postoperative hemorrhage. Hemorrhage from the mandibular molars is more common than bleeding from the maxillary molars (80% and 20%, respectively), because the floor of the mouth is highly vascular **(Moghadam and Caminiti, 2002)**. Patients who experience continued postoperative bleeding should be instructed to apply gauze pressure to the extraction site for 45 minutes. Bleeding can be minimized by using a good surgical technique and by avoiding the tearing of flaps or excessive trauma to bone and the overlying soft tissue **(Miloro *et al.*, 2004)**. The treatment of bleeding or hemorrhage begins with local measurements, pressure with gauze, and packing. Intraoperative bleeding from soft tissues can

usually be controlled with cautery, taking care to avoid any neurovascular structures. Intraalveolar hemostatic agents such as gelfoam, surgicel, or bone wax may be used alone or in various combinations. Over suturing and primary closure of the wound can also assist in hemostasis and Oral rinsing with an antiibrinolytic such as epsilon-aminocaproic acid (EACA) had the strongest antifibrinolytic effect or tranexamic acid can aid in maintenance of an organized clot **(Shastry *et al*.,2014)(Schlieve *et al*., 2022)**.

6.3 Infection

Infection of bone and soft tissue is a common complication that can be reduced with good surgical techniques. Some bacterial contamination of a surgical site is inevitable, either from the patient's bacterial flora or from the environment.The use of antibiotic prophylaxis in third molar surgery is widespread, but controversial **(Siddiqi *et al*., 2010)**.

6.4 Trismus

Trismus is a limitation in mouth opening defined as a maximal inter incisal opening (MIO)less than 35 mm in adults while themean maximum interincisal opening in adults varies from 47.5 to 58.6 mm, while in children it is 45 mm.**(Charters *et al*., 2022)**.The primary causes include elevation of flap beyond the external oblique ridge, low-grade infection following local anesthesia and repeated stimulation of the medial pterygoid muscle (inferior alveolar nerve block), as well as other causes. It is gradually alleviated or disappears within approximately 1 to 2 weeks postoperatively. however, in very rare cases, trismus persists for >1 month **(Zhang *et al*., 2021)**. And may persist for 3-4 months as experienced by many surgeons (self communication) **(Dr. Sahar, 2022)**.

6.5 Alveolar osteitis (dry socket)

The sequence of normal healing after extraction does not always occur. In some instances, early clot formation in the socket is followed by premature clot necrosis or lossin the extraction socket with intensive pain and foul odor production but no pus production. The pain starts in 48-72 h following extraction of the tooth, particularly after extraction of mandibular tooth, The bone become partially or completely exposed and patient present with intense pain radiating to the ear **(Abraham *et al*., 2016)**. The primary etiology appears to be one of excess fibrinolysis, with bacteria playing an important but yet ill-defined role**(Vezeau , 2000)**. Control the pain with a dressing material (e.g., Alvogyl paste) and use postoperative analgesics such as NSAIDs. The use of chlorhexidine 0.12% mouthwash after tooth extraction is safe and effective in reducing the incidence of AO in high-risk patients and Encourage them to maintain a good postoperative oral hygiene. **(Halabi *et al*., 2018)(Chemaly, 2013)**.

6.6 Neurosensory deficits

Injury to inferior alveolar nerve (IAN) and lingual nerve (LN) injuries is one of the complications of impacted lower third molar removalare uncommon but are troublesome complications when they do occur, and result in partial or total paresthesia of the ipsilateral lower lip and chin, and the anterior two-thirds of the tongue, respectively**(Mahon, 2014)(Ramadoria *et al*., 2019)(Juodzbalys and Daugela, 2013)**.The rate of sensory nerve damage after third molar surgery ranges from 0.5% to 20% **(Toptas *et al*.,2015)(Kim *et al*.,2012).** Major risk factors for inferior alveolar nerve damage have been found to be older age of the patient, ostectomy of the bone distal to the third molar, a close radiographical relationship between the roots of the third molar and the mandibular canal, and deflection of the mandibular canal. Anatomical factors such as lingual angulation of the third molar,

surgical procedures such as retraction of the lingual flap, vertical tooth sectioningand the surgeon's inexperience have been found to increase the risk of temporary lingual nerve damage**(Hill *et al*., 2002)**. The proximity of the tooth roots to the IAN has been traditionally assessed by OPGs. There are seven specific signs observed on panoramic radiograph which includes darkening of roots, deflection of roots, narrowing of roots, bifid root apex, diversion of the canal, narrowing of canal, and interruption in the white line of the canal. These specific signs indicate the risk of injury to the IAN during the surgery (**Neves *et al*., 2012)**.

The advent of 3-dimensional imaging using cone beam computed tomography (CBCT) allows greater clarity of the relationship of the mandibular canal with the impacted or buried mandibular third molar. The use of CBCT has been shown to be helpful in experienced hands in avoiding encroaching on the IAN intraoperatively **(Umar et a., 2013)**.

Nerve injuries were historically classified by**(Seddon ,1943)**based on three types of nerve fibre injury and whether there is continuity of the nerve.

1.Neurapraxia: The least severe form of nerve injury, commonly resulting in temporary numbness/paralysis with subsequent complete recovery within hours to months of the injury (average six to eight weeks). The structure of the nerve remains intact but the conduction impulses are interrupted by compression/ischaemia of the nerve.

2. Axonotmesis : A more severe form of nerve injury. Recovery takes weeks to years and occurs only by the regeneration of axons. There is disruption of the neuronal axon with Wallerian degeneration and yet the myelin sheath remains intact. This injury is usually caused by a severe crush, contusion or stretching of the nerve.

3. Neurotmesis : The most severe form of nerve injury. There is internal disruption of the architecture of the nerve with perineurium and endoneurium involvement.

Nerve damage can be subjectively described by patients as paraesthesia, anaesthesia or pain **(Smith and Lung, 2006)(Renton, 2010)**.

- Paraesthesia – represents abnormal sensations.
- Anaesthesia – Total absence of sensation, including pain or an insensitivity to all forms of stimuli that would normally be painful.
- Pain – An unpleasant sensory and emotional experience, associated with actual or potential tissue damage and/or described in terms of such damage.

Many physiological and psychological factors affect the severity and duration of postoperative pain including the patient's gender, age, education and personal approach to pain**.(Málek *et al*., 2017).** It may be difficult to avoid encountering the nerve during surgery because of itsvariable position. Despite every effort to avoid trauma to the lingual nerve during third molar extraction, lingual nerveanesthesia, paresthesia, or dysesthesia can result**(Bataineh, 2001).** Coronectomy significantly reduces inferior alveolar nerve injury even in high risk cases, with reduced morbidity and other associated complications in contrast to conventional technique**(Mukherjee *et al*., 2016)**.

6.7 Fracture of the mandible

Mandibular third molar is situated at the distal end of the body of the mandible where is connection with relatively thin ramus. There is the region of weakness and the fracture can occur if excessive force will be applied during impacted wisdom tooth elevation without preliminary and adequate removing of surrounding bone**(Juodzbalys and Daugela, 2013)**. The mandible contains a few mechanically weak portions, including the angle, the condylar process **(Mitsukawa *et al*.,2004)**.

Several factors have been proposed that influence the location of mandible fractures, including the site, direction, and severity of the force and impact, as well as the bone's intrinsic attributes. Fracture of the mandible occurs when the strength of the bone and the forces acting on it are not equal. The reduction of bone strength may be caused by physiological atrophy, osteoporosis, pathological processes (i.e., cystic lesion, malignant lesion, inflammatory condition), or may be secondary to surgical intervention **(Chrcanovic and Custódio, 2010)**. It should be treated immediately by Open reduction and internal fixation. Alternatively, closed reduction with intermaxillary fixation may be appropriate in certain cases **(Schlieve *et al*., 2022)**.

Case presentation

Case presentation

A 21-years-old female patient came to the clinic for orthodontic treatment with Panoramic radiograph showed that the Patient had asymptomatic impacted third molars in the mandible, as seen in the (Figure19). She is referred to the surgeon for extraction, after examination of the 3D cone beam computed tomograph showed that deeply impacted of the left third molar had 2 roots. The coronal section gives the position located close to the mandibular canal with classification of Class III position B mesioangular (Figure 20).

After surgical extraction of the deeply impacted third molar, the patient experienced pain, trismus, swelling, parasthesia and numbness in the tongue and lower lip that lasted for 2 months. Prednisolone and neurorubine prescribed to the patient. The outcomes of the treatment were evaluated at 7 days, 14 days, 30 days, 2 months clinically and full recovery occur after 3 months.

Figure (19) : Panoramic radiograph.

Figure (20) : Coronal section of the Cone beam computed tomography.

Discussion

Discussion

Adequate investigation is necessary to obtain an optimal treatment and action plan for the patient. Panoramic radiography is the standard imaging technique performed before mandibular third molar extraction to assess the anatomical risk factors **(Ruga *et al*., 2010)**. Panoramic radiography has advantages including common availability and low cost, Nevertheless, this radiographic examination presents a lack of details and resolution of some structures due to overlapping of anatomical structures in the image, mild distortion and magnification **(White and Pharoa, 2007) (Kamrun *et al*., 2013)**.

In the case of impaction, examining with CBCT 3D can provide the information necessary to assist the clinician while going to do the extraction on the tooth. The images can be obtained coronally, sagittally and axially, so that the anatomy, position, and dental relationships of the impacted teeth with the surrounding area can be analyzed **(Epsilawati and Fitria, 2018)**. Several radiographic characteristics identified on coronal CBCT images including direct contact between the inferior alveolar canal and root, buccal/lingual inferior alveolar canal position relative to root and cortication absence of inferior alveolar canal, which are associated with high risk of inferior alveolar nerve injury in impacted third molar surgery **(Wang *et al*., 2018)**.

The results of the study by **(Ghaeminia *et al*., 2011)** showed that the risk of inferior alveolar nerve injury was minimized after analyzing 3D images and due to the high resolution and low radiation dose in the case of CBCT, the use of CBCT is recommended **(Matzen and Wenzel, 2015)**.

Many factors have been reported as being associated with complications of third molar extraction include the surgeon's experience, the age and sex of the patient, the degree of operative tissue damage, surgical instruments, and postoperative

oedema. Proximity of the third molars to the inferior alveolar canal is the most predictive factor for inferior alveolar canal injury **(Bouloux *et al.*, 2007) (Bui *et al.*, 2003) (Jerjes *et al.*, 2010)**. However, there was no statistically significant relationship between inferior alveolar nerve injury and proximity of the corresponding tooth to the inferior alveolar canal **(Jerjes *et al.*, 2010)**.

The wisdom teeth extraction may cause lingual nerve damage that leads to numbness of the ipsilateral anterior two-thirds of the tongue and taste disturbance. Sometimes the elevation of lingual flaps and the experience of the operator are significant factors contributing to lingual nerve paraesthesia **(Sharanya and Sivakumar, 2018)**.

In most cases, inferior alveolar nerve paresthesia is temporary and recovers within 6 months **(Valmaseda-Castellón *et al.*, 2001)**, and the risk of permanent injury, in which sensory impairment lasts longer than 6 months, is less than 1%**(Gülicher and Gerlach, 2001)**.

Management of ectopic mandibular third molars is dependent on signs, symptoms and associated pathology. Pathology in the mandibular ramus and condyle can lead to serious complications such as condylar resorption, osteolysis and even condylar fracture**(Medici *et al.*, 2001)**.Treatment of ectopic third molars in the coronoid and condylar regions is recommended to avoid the morbidity caused by infec-tion of the cyst, malfunction of the temporomandibular joint, and risk of fracture in an area with a very thin bone. In cases of symptom-free highly aberrant wisdom teeth or without urgent necessity, annual follow-up visits to monitor the growth of the lesion are appropriate **(Fındık and Baykul, 2015)**.

Conclusion

Mandibular third molar extraction is a very commonly procedure to the dental practice and is undoubtedly associated with few risks especially neural injuries and therefore in the light of the existing evidence, adequate preoperative evaluation of the patient and meticulous surgical technique with minimum handling of the lingual flap are of paramount importance to diminish the incidence of nerve injury.

The risk of complications will always exist and it increases with increased surgical difficulty, hence, the patient should always be educated about the risks and benefits of surgery in order to ensure adequate surgical management of impacted mandibular third molar.

References

A

- Abhinaya, L.M., Arvind, M. and Rajendran, D., CBCT IMAGING IN ASSESSING IMPACTED THIRD MOLARS COVERING LETTER. *European Journal of Molecular & Clinical Medicine*, *7*(01), p.2020.
- Abraham, M.A., Azari, A., Westcott, J. and Stavropoulos, F., 2016. Dry Socket (Alveolar Osteitis, Fibrinolytic Osteitis). In *Atlas of Emergency Medicine Procedures* (pp. 373-374). Springer, New York, NY.
- Adachi M, Motohashi M, Nakashima M, Ehara Y, Azuma M, Muramatsu Y. Ectopic third molar tooth at the Mandibular notch. J Craniofac Surg. 2015;26:e455–6.
- Adeyemo WL. Do pathologies associated with impacted lower third molars justify prophylactic removal? A critical review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;102:448-52.
- Ahmed, N.M. and Speculand, B., 2012. Removal of ectopic mandibular third molar teeth: literature review and a report of three cases. *Oral Surgery*, *5*(1), pp.39-44.
- Akinbami Bo, Didia BC.” Analysis of body mass index, the mandible and dental alveolar factors in prediction of mandibular third molar impaction: a pilot study. Journal of contemporary dental practise, 2010, 11(6) E041-8
- Alfadil, L. and Almajed, E., 2020. Prevalence of impacted third molars and the reason for extraction in Saudi Arabia. *The Saudi Dental Journal*, *32*(5), pp.262-268.

- Alhadi, Y., Al-Shamahy, H.A., Aldilami, A., Al-Hamzy, M. and Al-Haddad, K.A., 2019. Prevalence and pattern of third molar impaction in sample of Yemeni adults. *On J Dent Oral Health*, *1*(5), pp.1-4.
- Almpani K, Papageorgiou SN, Papadopoulos MA (2015) Autotransplantation of teeth in humans: a systematic review and meta-analysis. Clinical Oral Investigations 19, 1157–79.
- Au AH, Choi SW, Cheung CW, Leung YY. The efficacy and clinical safety of various analgesic combinations for post-operative pain after third molar surgery: a systematic review and meta-analysis. PLoS ONE 2015;10:e0127611.
- Ayaz, H., 2012. POST-OPERATIVE COMPLICATIONS ASSOCIATED WITH IMPACTED MANDIBULAR THIRD MOLAR REMOVAL. *Pakistan Oral & Dental Journal*, *32*(3).
- Azenha MR, Kato RB, Bueno RBL, Neto PJO, Ribeiro MC. Accidents and complications associated to third molar surgeries performed by dentistry students. Oral Maxillofac Surg. 2014 Dec;18(4):459-464.

B

- Badawi Fayad J, Levy JC, Yazbeck C, Cavezian R, Cabanis EA. Eruption of third molars: relationship to inclination of adjacent molars. Am J Orthod Dentofacial Orthop. 2004;125:200-2.
- Baheerati, M.M. and Don, K.R., 2019. Applications of cone-beam computerized tomography in dental practice: A brief review. *Drug Invention Today*, *11*(1).
- Barbosa-Rebellato, N.L., Thomé, A.C., Costa-Maciel, C., Oliveira, J. and Scariot, R., 2011. Factors associated with complications of removal of third

molars: a transversal study. *Med Oral Patol Oral Cir Bucal*, *16*(3), pp.e376-80.

- Bataineh, A.B., 2001. Sensory nerve impairment following mandibular third molar surgery. *Journal of oral and maxillofacial surgery*, *59*(9), pp.1012-1017.
- Benediktsdóttir, I.S., Wenzel, A., Petersen, J.K. and Hintze, H., 2004. Mandibular third molar removal: risk indicators for extended operation time, postoperative pain, and complications. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *97*(4), pp.438-446.
- Berwick WA. Alternative method of flap reflection. Br Dent J 1966;20;121(6):295-6
- Blakey GH, Parker DW, Hull DJ, White RP Jr, Offenbacher S, Phillips C, *et al*. Impact of removal of asymptomatic third molars on periodontal pathology. JOral Maxillofac Surg 2009;67:245-50.
- Blum IR. Contemporary views on dry socket (alveolar osteitis): a clinical appraisal of standardization, aetiopathogenesis and management: a critical review. Int J Oral Maxillofac Surg. 2002;31:309-17.
- Bortoluzzi MC, Manfro R. Treatment for ectopic third molar in the subcondylar region planned with cone beam computed tomography: a case report. J Oral Maxillofac Surg. 2010;68:870–2.
- Bouloux GF, Steed MB, Perciaccante VJ. Complications of third molar surgery. *Oral Maxillofac Surg Clin North Am.* 2007;19:117–28. doi: 10.1016/j.coms.2006.11.013.
- Bowman J, O'Regan B, Bhopal S. Transmasseteric antero-parotid approach: a technique adaptation for ectopic subcondylar third molar removal and associated dentigerous cyst enucleation. Br J Oral Maxillofac Surg. 2014;52:e7–8.

- Breeland, G., Aktar, A. and Patel, B.C., 2021. Anatomy, head and neck, mandible. *StatPearls [Internet]*.
- Bui CH, Seldin EB, Dodson TB. Types, frequencies, and risk factors for complications after third molar extraction. *J Oral Maxillofac Surg.* 2003;61:1379–89. doi: 10.1016/j.joms.2003.04.001.

C

- Charters, E., Dunn, M., Cheng, K., Aung, V., Mukherjee, P., Froggatt, C., Dusseldorp, J.R. and Clark, J.R., 2022. Trismus therapy devices: A systematic review. *Oral Oncology*, *126*, p.105728.
- Chatterjee K,2014.Essentials of Dental Anatomy & Oral Histology.Jaypee Brothers Medical Publishers.
- Chemaly, D., 2013. How do I manage a patient with dry socket?. *Journal (Canadian Dental Association)*, *79*, pp.d54-d54.
- Cho, H., Lynham, A.J. and Hsu, E., 2017. Postoperative interventions to reduce inflammatory complications after third molar surgery: review of the current evidence. *Australian dental journal*, *62*(4), pp.412-419.
- Chrcanovic, B.R. and Custódio, A.L.N., 2010. Considerations of mandibular angle fractures during and after surgery for removal of third molars: a review of the literature. *Oral and maxillofacial surgery*, *14*(2), pp.71-80.
- Chung WC, Tu YK, Lin YH, Lu HK (2014) Outcomes of autotransplanted teeth with complete root formation: a systematic review and meta-analysis. Journal of Clinical Periodontology 41, 412–23

D

- Deliverska, E.G. and Petkova, M., 2016. Complications after extraction of impacted third molars-literature review. *Journal of IMAB–Annual Proceeding Scientific Papers*, *22*(3), pp.1202-1211.

E

- Epsilawati, L. and Fitria, I., 2018, February. Case Report: Mandibular Third Molar Impaction Features in CBCT 3D Radiography. In *International Dental Conference of Sumatera Utara 2017 (IDCSU 2017)* (pp. 116-119).
- Eric W. 2015, Anatomy for Dental Medicine - 2nd Ed - British Dental Journal.
- Eshghpour M, Nejat AH. Dry socket following surgical removal of impacted third molar in an Iranian population: incidence and risk factors. Niger J Clin Pract 2013;16:496-500.

F

- Fındık, Y. and Baykul, T., 2015. Ectopic third molar in the mandibular sigmoid notch: report of a case and literature review. *Journal of Clinical and Experimental Dentistry*, *7*(1), p.e133.
- Fuller, J.L., 1999. *Concise dental anatomy and morphology*. University of Iowa College of Dentistry.

G

- Gadre, K.S. and Waknis, P., 2010. Intra-oral removal of ectopic third molar in the mandibular condyle. *International journal of oral and maxillofacial surgery*, *39*(3), pp.294-296.

- Galié M, Candotto V, Elia G, Clauser LC (2015) Piezosurgery: a new and safe technique for distraction osteogenesis in Pierre Robin sequence review of the literature and case report. Int J Surg Case Rep 6:269–272
- Gbotolorun, O.M., Arotiba, G.T. and Ladeinde, A.L., 2007. Assessment of factors associated with surgical difficulty in impacted mandibular third molar extraction. *Journal of Oral and Maxillofacial Surgery*, *65*(10), pp.1977-1983.
- Ge, J., Yang, C., Zheng, J. and Qian, W., 2016. Piezosurgery for the lingual split technique in lingual positioned impacted mandibular third molar removal: a retrospective study. *Medicine*, *95*(12).
- Ghaeminia, H., Meijer, G.J., Soehardi, A., Borstlap, W.A., Mulder, J., Vlijmen, O.J.C., Bergé, S.J. and Maal, T.J.J., 2011. The use of cone beam CT for the removal of wisdom teeth changes the surgical approach compared with panoramic radiography: a pilot study. *International journal of oral and maxillofacial surgery*, *40*(8), pp.834-839.
- Grauvogel, J., Scheiwe, C. and Kaminsky, J., 2011. Use of piezosurgery for internal auditory canal drilling in acoustic neuroma surgery. *Acta neurochirurgica*, *153*(10), pp.1941-1947.
- Gülicher D, Gerlach KL. *Sensory impairment of the lingual and inferior alveolar nerves following removal of impacted mandibular third molars. Int J Oral Maxillofac Surg. 2001 Aug;30(4):306-12.*

H

- Halabi, D., Escobar, J., Alvarado, C., Martinez, N. and Muñoz, C., 2018. Chlorhexidine for prevention of alveolar osteitis: a randomised clinical trial. *Journal of Applied Oral Science*, *26*.

- Hasan, K.M., Sobhana, C.R., Rawat, S.K., Singh, D., Mongia, P. and Fakhruddin, A., 2021. Third molar impaction in different facial types and mandibular length: A cross-sectional study. *National Journal of Maxillofacial Surgery*, *12*(1), p.83.
- Hassan, A.H., 2010. Pattern of third molar impaction in a Saudi population. *Clinical, cosmetic and investigational dentistry*, *2*, p.109.
- Hennet, P., 2015. Piezoelectric bone surgery: a review of the literature and potential applications in veterinary oromaxillofacial surgery. *Frontiers in veterinary science*, *2*, p.8.
- Hiatt, J.L., 2020. *Textbook of head and neck anatomy*. Jones & Bartlett Publishers.
- Hill CM, Mostafa P, Thomas DW, Newcombe RG, Walker RV. Nerve morbidity following wisdom tooth removal under local and general anaesthesia. Br J Oral Maxillofac Surg 2002;39:419-22.
- Hupp, J.R. (2014). Principles of Management of Impacted Teeth. In: Ellis, E. E. 3rd, Tucker, M. R. (eds.), Contemporary Oral and Maxillofacial Surgery (6th ed.). Missouri: Elsevier Mosby, pp. 143- 147.
- Hupp, J.R., Tucker, M.R. and Ellis, E., 2013. *Contemporary Oral and maxillofacial surgery-E-book*. Elsevier health sciences.

I

- Iglesias-Martin, F., Infante-Cossio, P., Torres-Carranza, E., Prats-Golczer, V.E. and Garcia-Perla-Garcia, A., 2012. Ectopic third molar in the mandibular

condyle: a review of the literature. *Medicina oral, patologia oral y cirugia bucal*, *17*(6), p.e1013.

- Ishii S, Abe S, Moro A, Yokomizo N, Kobayashi Y. The horizontal inclination angle is associated with the risk of inferior alveolar nerve injury during the extraction of mandibular third molars. Int J Oral Maxillofac Surg 2017;46:1626-34.
- Iwanaga, J. and Tubbs, R.S., 2021. *Atlas of Oral and Maxillofacial Anatomy*. Springer.

J

- Jakse N, Bankaoglu V, Wimmer G, Eskici A, Pertl C. Primary wound healing after lower third molar surgery: evaluation of 2 different flap designs. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;93(1):7-12
- Jerjes W, Upile T, Nhembe F, Gudka D, Shah P, Abbas S, et al. Experience in third molar surgery: An update. Br Dent J 2010;209:E1.
- Jones, T.A., Garg, T. and Monaghan, A., 2004. Removal of a deeply impacted mandibular third molar through a sagittal split ramus osteotomy approach. *British Journal of Oral and Maxillofacial Surgery*, *42*(4), pp.365-368.
- Juodzbalys G, Daugela P. Mandibular third molar impaction: Review of literature and a proposal of a classification. J Oral Maxillofac Res 2013;4:e1.

K

- Karaca, I., Şimşek, Ş., Uğar, D. and Bozkaya, S., 2007. Review of flap design influence on the health of the periodontium after mandibular third molar

surgery. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *104*(1), pp.18-23.

- Kamrun N, Tetsumura A, Nomura Y, et al. Visualization of the superior and inferior borders of the mandibular canal: a comparative study using digital panoramic radiographs and cross-sectional computed tomography images. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2013;115:550–7.
- Kavarthapu, A. and Thamaraiselvan, M., 2018. Assessing the variation in course and position of inferior alveolar nerve among south Indian population: A cone beam computed tomographic study. *Indian Journal of Dental Research*, *29*(4), p.405.
- Kaya GS, Aslan M, Ömezli MM, Dayi E (2010) Some morphological features related to mandibular third molar impaction. Journal of Clinical and Experimental Dentistry 2(1): e12-e17.
- Keyhan, S.O., Fallahi, H.R., Cheshmi, B., Mokhtari, S., Zandian, D. and Yousefi, P., 2019. Use of piezoelectric surgery and Er: YAG laser: which one is more effective during impacted third molar surgery?. *Maxillofacial Plastic and Reconstructive Surgery*, *41*(1), pp.1-10.
- Khan I, Halli R, Gadre P, Gadre KS. Correlation of panoramic radiographs and spiral CT scan in the preoperative assessment of intimacy of the inferior alveolar canal to impacted mandibular third molars. J Craniofac Surg 2011;22:566-70
- Kim JW, Cha IH, Kim SJ, Kim MR. Which risk factors are associated with neurosensory deficits of inferior alveolar nerve after mandibular third molar extraction? J Oral Maxillofac Surg 2012;70:2508-14.
- Koc N, Boyacioglu Dogru H, Cagirankaya LB et. al. CBCT assessment of gubernacular canals in relation to eruption disturbance and pathologic condition

associated with impacted/unerupted teeth. Oral Surg Oral Med Oral Pathol Oral Radiol. 2019 Feb;127(2):175-184.

- Komerik, N., Muglali, M., Tas, B. and Selcuk, U., 2014. Difficulty of impacted mandibular third molar tooth removal: predictive ability of senior surgeons and residents. *Journal of Oral and Maxillofacial Surgery*, *72*(6), pp.1062-e1.
- KUMAR, S. & VIMALAKSHAN, I. 2017. Complications of Impacted Lower Third Molar Surgery and its Management. International Journal of Pharmaceutical Sciences Review and Research, 43, 8-12.
- Kumar, S., Reddy, M.P., Chandra, L. and Bhatnagar, A., 2014. The "red line" conundrum: a concept beyond its expiry date?. *Journal of maxillofacial and oral surgery*, *13*(4), pp.612-614.

L

- Laino L, Menditti D, Lo Muzio L, Laino G, Lauritano F, Cicciu M. Extraoral surgical approach of ectopic mandibular third molar to the lower border of mandible. J Craniofac Surg. 2015;26:e256–60.
- Latt, M.M., Chewpreecha, P. and Wongsirichat, N., 2015. Prediction of difficulty in impacted lower third molars extraction; review literature.
- Lee, Y.K., Park, S.S. and Myoung, H., 2013. Surgical extraction of mandibular third molar in pterygomandibular space: a case report. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, *39*(5), pp.242-245.
- Lipski, M., Tomaszewska, I.M., Lipska, W., Lis, G.J. and Tomaszewski, K.A., 2013. The mandible and its foramen: anatomy, anthropology, embryology and resulting clinical implications. *Folia morphologica*, *72*(4), pp.285-292.

M

- Mahon, N., 2014. Post-extraction inferior alveolar nerve neurosensory disturbances: A guide to their evaluation and practical management.
- Málek, J., Ševčík, P., Bejšovec, D., Gabrhelík, T., Hnilicová, M., Křikava, I. and Mixa, V., 2017. Postoperative pain management. *Prague, Czech Republic: Mladá fronta*, pp.102-11.
- MALIK, N. 2012. Textbook of oral and maxillofacial surgery 3rd edition. Jaypee: Newdelhi, 637,635,929-930.
- Magnus WW, Castner DV Jr, Hiatt WR. An alternative method of flap reflection of mandibular third molars. Mil Med 1972;137(6):232-3.
- Mansuri S, Mujeeb A, Hussain SA, Hussain MA. Mandibular third molar impactions in male adults: Relationship of Operative time and Types of impaction on inflammatory complications. J Int Oral Health 2014;6:9-15.
- Matsuyama, J., Kinoshita-Kawano, S., Hayashi-Sakai, S., Mitomi, T. and Sano-Asahito, T., 2015. Severe impaction of the primary mandibular second molar accompanied by displacement of the permanent second premolar. *Case reports in dentistry*, *2015*.
- Matzen, L.H. and Wenzel, A., 2015. Efficacy of CBCT for assessment of impacted mandibular third molars: a review–based on a hierarchical model of evidence. *Dentomaxillofacial Radiology*, *44*(1), p.20140189.
- Medici A, Raho MT, Anghinomi M. Ectopic third molar in the condylar process: case report. Acta Biomed Ateneo Parmense 2001;72:115–8.

- Mendes, R.A. and Rocha, G., 2004. Mandibular third molar autotransplantation-literature review with clinical cases. *J Can Dent Assoc*, *70*(11), pp.761-6.
- Mettes TD, Ghaeminia H, Nienhuijs ME, Perry J, van der Sanden WJ, Plasschaert A. Surgical removal versus retention for the management of asymptomatic impacted wisdom teeth. Cochrane Database Syst Rev 2012;6:CD003879.
- Miloro M, Ghali GE, Larsen PE, Waite PD, Decker BC. Peterson's principles of oral and maxillofacial surgery. Inc Hamilton, Second Edition, 2004.
- Mitsukawa N, Satoh K, Uemura T, Hosaka Y (2004) An unusual traumatic fracture of mandibular symphysis resembling horizontal osteotomy for genioplasty. J Craniofac Surg 15:229–331
- Moghadam, H.G. and Caminiti, M.F., 2002. Life-threatening hemorrhage after extraction of third molars: case report and management protocol. *Journal-Canadian Dental Association*, *68*(11), pp.670-675.
- Moghimi, M., Baart, J. A., Hakki Karagozoglu, K. & Forouzanfar, T. Spread of odontogenic infections: A retrospective analysis and review of the literature. Quintessence Int. 44, 351–361 (2013).
- Mukherjee, S., Vikraman, B. and Duraiswamy Sankar, M.S.V., 2016. Evaluation of outcome following coronectomy for the management of mandibular third molars in close proximity to inferior alveolar nerve. *Journal of clinical and diagnostic research: JCDR*, *10*(8), p.ZC57.

N

- Nageshwar. Comma incision for impacted mandibular third molars. J Oral Maxillofac Surg 2002;60(12):1506-9.

- Narendar, R., Kavin, T., Indra, K., Tamil, T. and Murugan, A., 2019. Conundrum behind Impacted Third Molar-A Review of Literature. *IJRR*, *6*(4), p.177.
- Nelson, S.J., 2015. *Wheeler's Dental Anatomy, Physiology and Occlusion: 1st SAE-E-book*. Elsevier Health Sciences.
- Neves FS, Souza TC, Almeida SM, Haiter-Neto F, Freitas DQ, Bóscolo FN, et al. Correlation of panoramic radiography and cone beam CT findings in the assessment of the relationship between impacted mandibular third molars and the mandibular canal. DentomaxillofacRadiol. 2012;41:553–7.
- Nguyen, E., Grubor, D. and Chandu, A., 2014. Risk factors for permanent injury of inferior alveolar and lingual nerves during third molar surgery. *Journal of Oral and Maxillofacial Surgery*, *72*(12), pp.2394-2401.

O

- O'Dwyer, S., Kelly, M. and Pierse, D., 2019. Extraction of a severely impacted mandibular third molar using a sagittal split osteotomy-a case report. *Journal of the Irish Dental Association*, *65*(6).
- Oenning, A.C.C., Neves, F.S., Alencar, P.N.B., Prado, R.F., Groppo, F.C. and Haiter-Neto, F., 2014. External root resorption of the second molar associated with third molar impaction: comparison of panoramic radiography and cone beam computed tomography. *Journal of Oral and Maxillofacial Surgery*, *72*(8), pp.1444-1455.

P

- Passi, D., Pal, U.S., Mohammad, S., Singh, R.K., Mehrotra, D., Singh, G., Kumar, M., Chellappa, A.A. and Gupta, C., 2013. Laser vs bur for bone cutting

in impacted mandibular third molar surgery: a randomized controlled trial. *Journal of Oral Biology and Craniofacial Research*, *3*(2), pp.57-62.Passi, D., Singh, G., Dutta, S., Srivastava, D., Chandra, L., Mishra, S., Srivastava, A. and Dubey, M., 2019.

- Peterson, L.J.; Ellis, E.I.I.I.; Hupp, J.R.; Tuker, M.R. Principles of Management of Impacted Teeth. Contemporary Oral and Maxillofacial Surgery, 3rd ed.; Elsever: St. Louis, MO, USA, 1998.
- Polat HB, Ozan F, Kara I, Ozdemir H, Ay S. Prevalence of commonly found pathoses associated with mandibular impacted third molars based on panoramic radiographs in Turkish population. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105:e41-7
- Primo, F.T., Primo, B.T., Scheffer, M.A.R., Hernández, P.A.G. and Rivaldo, E.G., 2017. Evaluation of 1211 third molars positions according to the classification of Winter, Pell & Gregory. *Int J Odontostomatol*, *11*(1), pp.61-5.

Q

- QUEK, S., TAY, C., TAY, K., TOH, S. & LIM, K. 2003a. Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey. International journal of oral and maxillofacial surgery, 32, 548-552.

R

- Rajkumar, K. and Ramya, R., 2017. *Textbook of Oral Anatomy, Physiology, Histology and Tooth Morphology*. Wolters kluwer india Pvt Ltd.

- Ramadorai, A., Tay, A.B., Vasanthakumar, G. and Lye, W.K., 2019. Nerve injury after surgical excision of mandibular third molars under local anesthesia: an audit. *Journal of Maxillofacial and Oral Surgery*, *18*(2), pp.307-313.
- Refahi, R., Zarch, R.E. and Naeimi, M., 2021. The effect of Cutanplast on swelling and pain after impacted third molar removal surgery: A randomized controlled study. *Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology*, *33*(3), pp.256-259.
- Rahnama M, Czupkałło Ł, Czajkowski L, Grasza J, Wallner J (2013) The use of piezosurgery as an alternative method of minimally invasive surgery in the authors' experience. Videosurgery Other Miniinvasive Techniques 8(4):321
- Renton T, Yilmaz Z, Gaballah K. Evaluation of trigeminal nerve injuries in relation to third molar surgery in a prospective patient cohort. Recommendations for prevention. Int J Oral Maxillofac Surg 2012;41:1509-18.
- Rodella, L.F., Buffoli, B., Labanca, M. and Rezzani, R., 2012. A review of the mandibular and maxillary nerve supplies and their clinical relevance. *Archives of oral biology*, *57*(4), pp.323-334.
- Rosa AL, Carneiro MG, Lavrador MA, Novaes AB Jr. Influence of flap design on periodontal healing of second molars after extraction of impacted mandibular third molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;93(4):404-7.
- Rubio, E.D. and Morumbo, M., 2019. Sagittal split osteotomy for deeply impacted third molars removal. an overtreatment?. *International Journal of Oral and Maxillofacial Surgery*, *48*, p.68.
- Ruga E., Gallesio C., Boffano P. Mandibular alveolar neurovascular bundle injury associated with impacted third molar surgery. *J Craniofac Surg.* 2010;21(4):1175–1177.

S

- Saman, M., Abramowitz, J.M. and Buchbinder, D., 2013. Mandibular Osteotomies and Distraction Osteogenesis. *JAMA facial plastic surgery*.
- Sammartino, G., Gasparro, R., Marenzi, G., Trosino, O., Mariniello, M. and Riccitiello, F., 2017. Extraction of mandibular third molars: proposal of a new scale of difficulty. *British Journal of Oral and Maxillofacial Surgery*, *55*(9), pp.952-957.
- Santos, P.L., Marotto, A.P., da Silva, T.Z., Bottura, M.P., Valencise, M., Marques, D.O. and Queiroz, T.P., 2020. Is low-level laser therapy effective for pain control after the surgical removal of unerupted third molars? A randomized trial. *Journal of Oral and Maxillofacial Surgery*, *78*(2), pp.184-189.
- Santosh, P., 2015. Impacted mandibular third molars: Review of literature and a proposal of a combined clinical and radiological classification. *Annals of medical and health sciences research*, *5*(4), pp.229-234.
- Satwik, A. and Naveed, N., 2014. Third molar impaction-review. *Research Journal of Pharmacy and Technology*, *7*(12), p.12.
- Scarfe W, Farman A. Cone-beam computed tomography: volume preparation. In: White S, Pharoah M, eds. *Oral radiology: principles and interpretation*. St Louis, MO: Mosby Elsevier; 2014. pp. 199–213.
- Schlieve, T., Hussain, R.A. and Miloro, M., 2022. Third molar surgery. *Management of complications in oral and maxillofacial surgery*, pp.25-46.
- Seddon, H.J. Three types of nerve injury. Brain 1943; 66: 237 – 288
- Sencimen, M., Varol, A., Gülses, A. and Altug, A.H., 2009. Extraction of a deeply impacted lower third molar by sagittal split osteotomy. *Oral Surgery,*

Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, *108*(5), pp.e36-e38.

- Sharanya, H. and Sivakumar, M., 2018. Incidence of Lingual Nerve Paresthesia Following Third Molar Extraction. *Journal of Pharmaceutical Sciences and Research*, *10*(3), pp.581-582.
- Shastry, S.P., Kaul, R., Baroudi, K. and Umar, D., 2014. Hemophilia A: Dental considerations and management. *Journal of International Society of Preventive & Community Dentistry*, *4*(Suppl 3), p.S147.
- Siddiqi, A., Morkel, J.A. and Zafar, S., 2010. Antibiotic prophylaxis in third molar surgery: A randomized double-blind placebo-controlled clinical trial using split-mouth technique. *International journal of oral and maxillofacial surgery*, *39*(2), pp.107-114.
- Singh, V., Alex, K., Pradhan, R., Mohammad, S. and Singh, N., 2013. Techniques in the removal of impacted mandibular third molar: A comparative study. *European Journal of General Dentistry*, *2*(01), pp.25-30.
- Song, F., Landes, D.P., Glenny, A.M. and Sheldon, T.A., 1997. Prophylactic removal of impacted third molars: an assessment of published reviews. *British dental journal*, *182*(9), pp.339-346.
- Stanaitytė, R., Trakinienė, G. & Gervickas, A. Do wisdom teeth induce lower anterior teeth crowding? A systematic literature review. Stomatologija. 16, 15–18 (2014)
- Sukegawa, S. et al. Do the presence of mandibular third molar and the occlusal support afect the occurrence and the mode of mandibular condylar fractures?. J. Hard Tissue Biol. 28, 377–382 (2019).
- Susarla, S.M. and Dodson, T.B., 2004. Risk factors for third molar extraction difficulty. *Journal of oral and maxillofacial surgery*, *62*(11), pp.1363-1371.
- Szmyd L. Impacted teeth. Dent Clin North Am 1971;15:299-318.

T

- Toptas O, Baykul T, Basak K. Does smoking affect the Ki67 and p53 Expressions in asymptomatic fully impacted lower third molar follicles? J Oral Maxillofac Surg 2015;73:819-26.
- Tsukiboshi M. Autotransplantation of teeth. Chicago: Quintessence Publishing Co, Inc; 2001.
- Tiwari D., Srivastava A., Saha GK., 2019. Comparison between conventional rotary surgical technique and chisel mallet technique for surgical removal of impacted mandibular third molar. Int J of Recent Scientific Research Vol. 10, Issue, 09(A), pp. 34594-34599 .

U

- Umar G, Obisesan O, Bryant C, Rood JP. Elimination of permanent injuries to the inferior alveolar nerve following surgical intervention of the "high risk" third molar. Br J Oral Maxillofac Surg. 2013;51:353–357.

V

- Valmaseda-Castellón E, Berini-Aytés L, Gay-Escoda C. *Inferior alveolar nerve damage after lower third molar surgical extraction: a prospective study of 1117 surgical extractions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001 Oct;92(4):377-83.*
- Vezeau PJ. Dental Extraction Wound Management: Medicating Postextraction Sockets. Int J Oral Maxillofac Surg. 2000, May;58(5): 531-537.

- Vilela, E.M. and Vitoi, P.A., 2011. Study of position and eruption of lower third molars in adolescents. *RSBO Revista Sul-Brasileira de Odontologia*, *8*(4), pp.390-397.
- Vivek, M., Ebenezer, V. and Balakrishnan, R., 2015. Bur technique and Chisel Mallet technique in impacted 3rd molar. *Biomedical and Pharmacology Journal*, *7*(1), pp.281-284.

W

- Wahab, A.A.C., Zulkifle, N.I., Adam, K.B.C. and Jamali, N.R., 2022. Minor oral surgery on impacted lower third molar done by IIUM Undergraduates: a retrospective study. *IIUM Journal of Orofacial and Health Sciences*, *3*(1), pp.84-94.
- Ward TG. Split bone technique for removal of lower third molar. Br Dent J 1956;101:297-301.
- Wang, D., Lin, T., Wang, Y., Sun, C., Yang, L., Jiang, H. and Cheng, J., 2018. Radiographic features of anatomic relationship between impacted third molar and inferior alveolar canal on coronal CBCT images: risk factors for nerve injury after tooth extraction. *Archives of Medical Science: AMS*, *14*(3), p.532.
- White SC, Pharoa MJ. Oral Radiology: Principles and Interpretation. 5th ed. Saint Louis: Mosby; 2007.
- Winter GB (1926) Impacted mandibular third molars. St Louis: American Medical Book Co, pp. 241-279.
- Wu, Y., Song, Y., Huang, R., Hu, J., He, X., Wang, Y., Zhou, G., Sun, C., Jiang, H., Cheng, J. and Wang, D., 2017. Comprehensive analysis of ectopic mandibular third molar: a rare clinical entity revisited. *Head & Face Medicine*, *13*(1), pp.1-9.

Y

- Yolcu, Ü.M.İ.T. and Acar, A.H., 2015. Comparison of a new flap design with the routinely used triangular flap design in third molar surgery. *International journal of oral and maxillofacial surgery*, *44*(11), pp.1390-1397.

Z

- Zhang, Y., Zhuang, P., Jia, B., Xu, J., Cui, Q., Nie, L., Wang, Z. and Zhang, Z., 2021. Persistent trismus following mandibular third molar extraction and its management: A case report and literature review. *World Academy of Sciences Journal*, *3*(1), pp.1-1.