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Juxta apical radiolucency

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بسم الله الرحمن الرحيم

"وَأَنْ لَيْسَ لِلإنسَانِ إِلاَّ مَا سَعَى

وَأَنَّ سَعْيَهُ سَوْفَ يُرَى"

"سورة النجم"

Certification of the Supervisor

I certify that this project entitled **"Juxta apical radiolucency"** was prepared by the fifth-year student **Mariem Safaa Dawood** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Dedication

To my role model, the way I'm walking on and my light in the dark, my father.

To my all time every step supporter, my decision in confusion, my refuge in weakness, my mother.

To the givers of endless love, who are there when the real need is, my brothers.

To the people who are close to my soul, to those who have accompanied me every step of the way, to the company of this journey and to those who have shared with me its difficulties, to those who are always there for me, I dedicate this research ..

Sincerely,

Mariem Safaa

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List of abbreviation

IAN	Inferior alveolar nerve
CBCT	Cone-beam computed tomography systems
JAR	Juxta-apical radiolucencies
OPG	Orthopantomagram
IMTMs	Impacted mandibular third molar
CT	Computerized tomography

Aim or review

The aim of this study is to define the Juxta apical radiolucency as well as to evaluate its relation to the surrounding structures.

Introduction

Impacted tooth is a tooth that persists in the jaw and does not erupt into its natural functional position after its expected eruption time **(Pechalova et al., 2017).**

The mandibular third molar is one of the most commonly impacted tooth in the jaws with a prevalence that may reach up to 70% of the population **(Bede, 2018).**

Extraction of impacted or erupted mandibular third molars is one of the most frequent dentoalveolar surgical procedures **(Grossi et al., 2007).**

These teeth are in close proximity to important structures, including the inferior alveolar nerve, the lingual nerve, and the adjacent second molars. Generally, injury to the inferior alveolar nerve is a major concern for surgeons. The incidence of temporary and permanent inferior alveolar nerve neuropathy, associated with mandibular third molar surgeries, is estimated at 1-20 % and 0-3.6 %, respectively **(Renton et al., 2005; Renton, 2013).**

The majority of injuries result in transient sensory disturbances, while in some cases, permanent paresthesia, hypoesthesia, or even dysesthesia may occur. These sensory disturbances can cause speech and mastication problems and adversely affect the patient's quality of life. They also constitute one of the most frequent causes of medical complaints and litigation **(Loescher et al., 2003).**

The radiographic position of the mandibular third molars relative to the mandibular canal has been shown to be useful in assessing the risk of damage to the inferior alveolar nerve following extraction **(Kipp et al.,1980; Wofford and Miller, 1987; Rood and Shehab, 1990).**

Seven radiographic signs in orthopantomogram (OPG) can increase the incidence of injury to the inferior alveolar nerve, including the darkening of the roots, diversion of the canal, and interruption of the white line of the canal, which are assumed to be the best predictive signs of neurosensory deficits **(Gilvetti et al., 2019).**

In 2005, Renton et al. introduced the juxta-apical area (JAA) or juxta-apical radiolucency (JAR) as a new predictive sign**.** JAR is a well-defined area of radiolucency that is apical or lateral to the roots of mandibular third molars **(Renton et al., 2005).**

In 2010, Umar et al. showed that JAR is a large cancellous bone space, which is superimposed on the inferior alveolar canal and is not always in contact with it **(Umar et al., 2010).**

Other researchers have also investigated the relationship between JAR, the inferior alveolar nerve (IAN), and the third molar roots **(Nascimento et al., 2017; Nascimento et al., 2018; Khojastepour et al., 2020).**

They established that JAR is commonly located buccally or superiorly to the canal and introduced the concept of a JAR- associated IAN injury. They suggested that thinning of the cortical plate could be responsible for postoperative IAN injury following the extraction of third molars **(Nascimento et al., 2017; Nascimento et al., 2018).**

Moreover, Gilvetti et al. evaluated IAN injury in patients with JAR following the third molar surgery, based on panoramic radiography. According to their study, the presence of JAR is not a reliable predictor of the risk of permanent injury to the inferior alveolar nerve **(Gilvetti et al., 2019).**

CHAPTER ONE : REVIEW OF LITERATURE

1.Impacted mandibular third molar

1.1.Definition

An Impacted tooth is defined as a tooth that remains in the jaw and does not erupt into its normal functional position beyond its normal time of eruption **(Pechalova et al., 2017).**

Third molars in maxilla and mandible are the most often impacted teeth followed by canines in the maxilla and premolars in the mandible. The mandibular third molars are the most affected because the last teeth to erupt and do not have enough space for a complete eruption **(Hupp et al., 2013; Santosh, 2015).**

In oral and maxillofacial surgery, one of the most frequent oral procedures done each day is the surgical removal of impacted mandibular third molars **(Chaudhary et al., 2015).**

1.2.Development and eruption

Mandibular third molars arising from the dental lamina as successional teeth. The tooth bud of the mandibular third molar becomes obvious at 4-5 years of age **(Korbendau and Korbendau, 2019).**

Mineralization mostly starting at eight to nine years **(Ragini et al., 2003).**

The crown of mandibular third molar is ordinarily complete in age range between 12-15 years old while eruption of mandibular third molar is greatly variable, mostly occurring between 17-24 years of age **(Fayad et al., 2004; Korbendau and Korbendau, 2019)**.

1.3.Prevalence of impacted teeth

Many studies have demonstrated that there is no sexual predilection in the incidence of impacted mandibular third molars **(Niedzielska et al., 2006).**

However, some authors have stated higher rate of occurrence in females **(Upadhyaya et al., 2017).**

A retrospective study done by **Krishnan et al., 2009** stated that the majority of patients who underwent a surgical removal of impacted mandibular third molars were in the age group between 15 and 30 years. **(Ragini et al., 2003).**

Furthermore, a study conducted by **Ayaz, 2012** showed that the most common age group was the third decade (20 - 30 years old) (58.5%).

1.4.Etiology of impacted mandibular third molars

The mandibular third molars are the most commonly impacted teeth because they are the last teeth to erupt and usually remain impacted due to the lack of space in the lower jaw **(Kaczor Urbanowicz et al., 2016).**

The absence of adequate space in dental arch count for about 49.64% of all impacted teeth. Extraction of premolars during the active time of eruption reduce the possibility of impacted third molars and this is due to the mesial drift of molars to close the created space **(Mendoza-Garcia et al., 2017).**

The evolutionary development of human being led to smaller sizes of the maxilla and mandible that are insufficient for the eruption of molars. This jaw impairment in dimensions opinion may be caused by the concept that sufficient mastication effort. cannot be provided in contemporary nutrition style, and this why modern individual has impacted teeth **(Santosh, 2015).**

Patel et al., 2015 suggested that impaired third molar eruption occurs when remodeling of the ramus is insufficient and retromolar space is inadequate to house the last tooth. Dilaceration of roots can also result in lower third molar impaction

(Nadaes et al., 2016).

Other important causes, according to several authors, include tooth germ malposition, hereditary factors, systemic factors such as endocrine hormones deficiencies (e.g. hypothyroidism) and in cleidocranial dysostosis **(Juodzbalys and Daugela, 2013).**

The presence of pathological lesions could also be a local factor that prevent teeth eruption (about 4.20%), such as dentigerous cysts, keratocytes and odontoma **(Hou et al., 2010).**

1.5.Classification systems of impacted mandibular third molars

Mandibular third molar impaction is classified to minimize the complications of surgical extraction and to assess the procedure difficulty to create an optimal treatment plan **(Santosh, 2015).**

Ahmed et al., 2016 mentioned that it is fundamental for the surgeon to assess if there are any complications expected to occur during extraction of a buried tooth by obtaining the information regarding tooth position in relation to the ramus, if there is close proximity to vital structures such as inferior alveolar nerve, anatomy of the tooth, roots shape and tooth relationship to adjacent lower second molar.

1) Angulation

Winter's system is the most commonly used for planning the treatment for impacted mandibular third molars, it also aids in assessment of the surgical difficulty. This system depends on determining the angle between the long axis of the impacted mandibular third molar and its relation to the long axis of the mandibular second molar **(Kruger et al., 2001).**

The most common angulation type is mesioangular impaction which is the simplest one to be removed especially when it is partially erupted, it is characterized by mesial inclination of the mandibular 3rd molar crown ranged from 11° to 79° toward the 2nd molar. In vertical type of impaction, which is the second most common one, the long axis of the third molar is 10° to -10° to the second molar. Distoangular position, which is the most difficult one during extraction, because the pathway of removal is toward the mandibular ramus, as the long axis of the tooth is posteriorly or distally angled -11° to -79° to the second molar. Finally, if the long axis of 3rd molar is in perpendicular relation 80° to 100° with long axis of 2nd molar, this position is known as horizontal impaction **(Kruger et al., 2001)**, as show in table (1.1).

Inverted impaction has been described as complicated as the crown points downwards and root points towards the alveolar crest. In the mandible, the most common location of inverted impacted 3rd molar is in the ascending ramus. In rare occasions, transverse impaction can be seen in which the tooth is absolutely in horizontal location in buccolingual direction where the occlusal surface of the tooth can be in lingual direction **(Hupp et al., 2013).**

Impaction type	The angle of M3's Long axis in relation to second molar	
Vertical	10° to -10°	
Mesioangular	11° to 79°	
Horizontal	80° to 100°	
Distoangular	-11° to -79°	

Table (1.1) Winter's classification **(Yassaei et al., 2014).**

Winter's lines are three imaginary lines as shown in Fig. (1.1) were used to assess the difficulty of the extraction as mentioned by **Malik, 2012.**

White line: indicates depth of the third molar related to the occlusal plane. This line is drawn running on the occlusal surfaces of first and second molar and continue posteriorly over area of the impacted tooth.

Amber line: represents the height of alveolar bone level. This line is drawn to symbolize the crest of the interdental septum between adjacent molars and extended posteriorly and continue with the ascending ramus.

Red line: represents how much bone must be removed to deliver a tooth. This line is drawn from an imaginary elevator application point, ascending to cross the amber line perpendicularly.

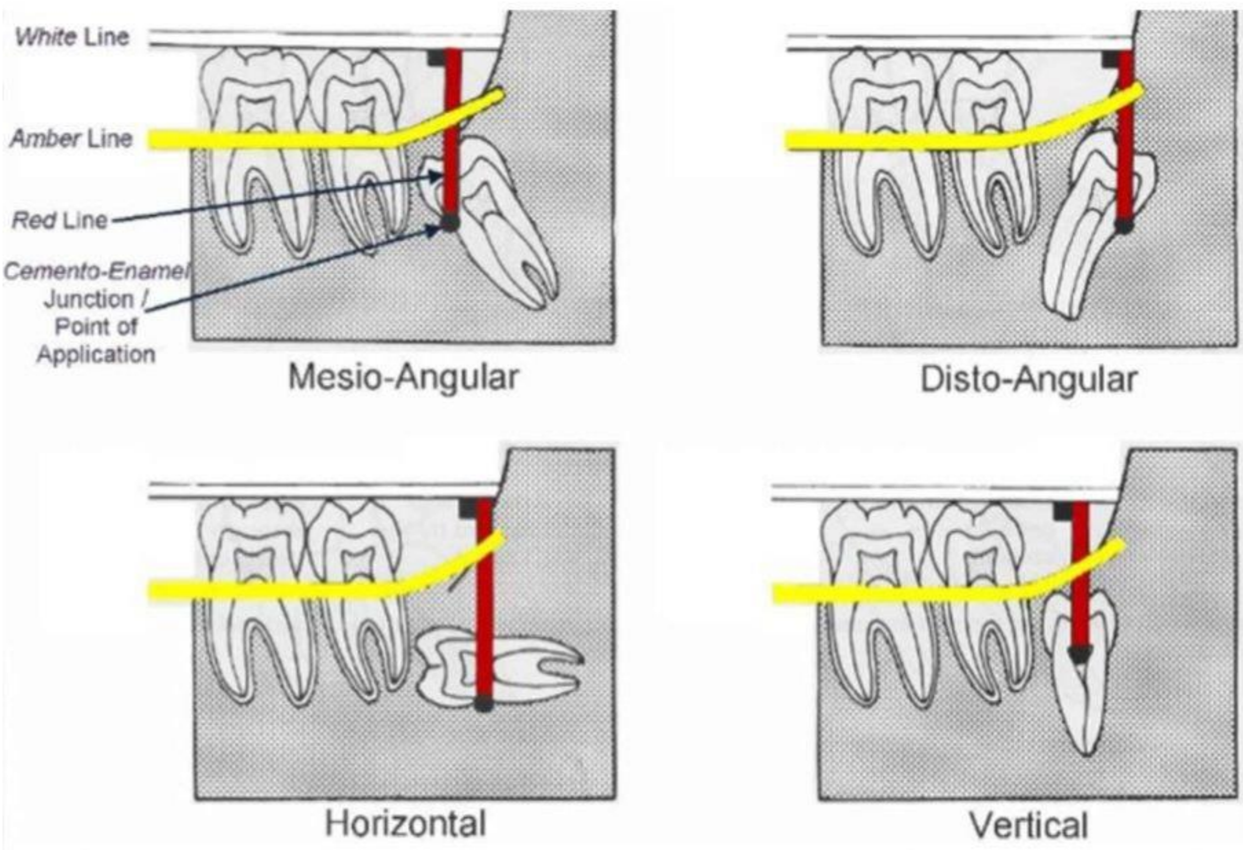

Figure (1.1) Winter's lines **(Malik, 2012)**

According to Winter's classification, the CBCT pictures were divided into four types of impaction: vertical, horizontal, mesioangular, and distoangular (Figure 1.2) **(Mahvash et al, 2021).**

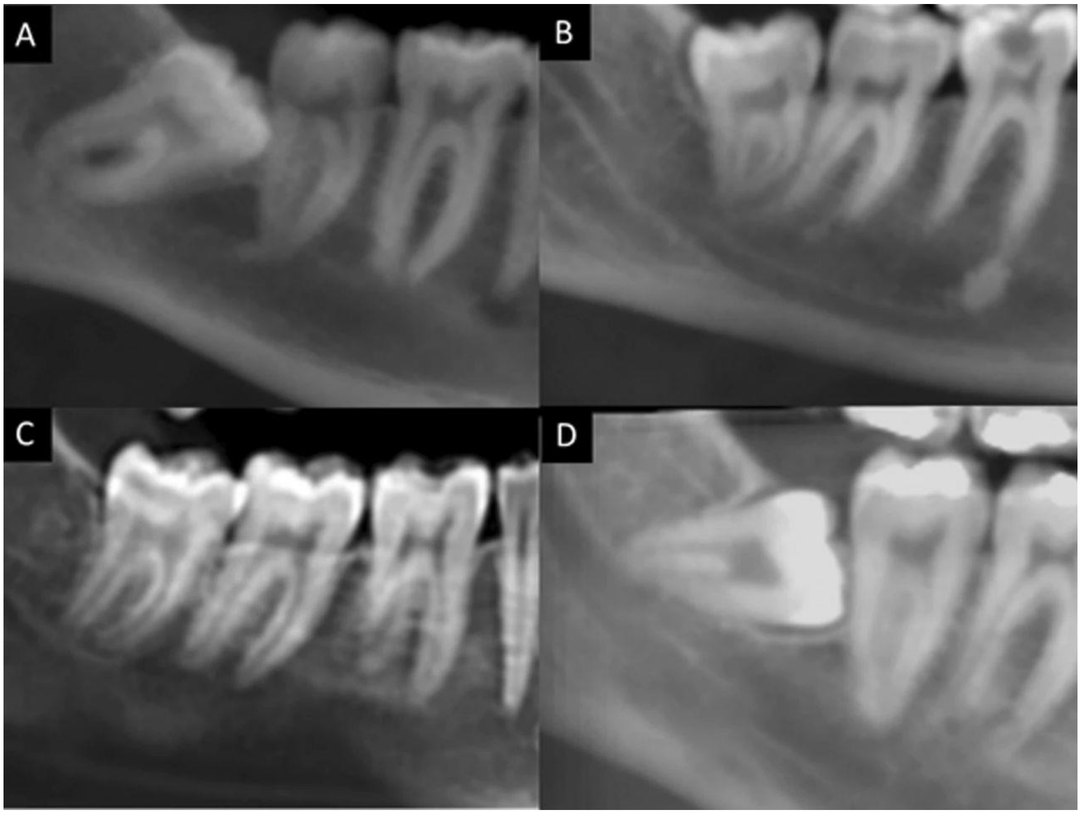

Figure (1.2) Classification of third molars based on angulation: mesioangular (A), distoangular (B), vertical (C), and horizontal (D) **(Mahvash et al, 2021).**

2) Pell and Gregory's classification

Pell and Gregory classified impacted mandibular third molars as illustrated in (Figure 1.3), **(Siddiqimet et al., 2010)**:

1. The first category relates to the mandibular third molar's position within the bone, it classifies impacted mandibular third molars into 3 positions:

Position A: The impacted tooth's occlusal plane is at the same level as the second molar's occlusal plane.

Position B: The impacted tooth's occlusal plane lies between the second molar's cervical margin and its occlusal plane.

Position C: The impacted tooth is below the cervical margin of the second molar.

2.The second category is related to the relationship between the tooth and ramus of the mandible; it classifies impacted mandibular third molars into 3 classes:

Class 1 : The third molar can erupt because there is enough space between the distal surface of the second molar and the anterior border of the ascending ramus.

Class 2: the space between the second molar's distal aspect and the anterior border of the ramus is less than the third molar's crown's mesio-distal width. It implies that bone from the ascending ramus covers the third molar's distal portion of the crown.

Class 3: Due to an extreme lack of space, the third molar is fully embedded in the bone along the anterior border of the ascending ramus. Class 3 teeth are obviously more challenging to remove because too much bone must be removed out and there is a chance of damaging to the inferior alveolar nerve or fracturing the mandible.

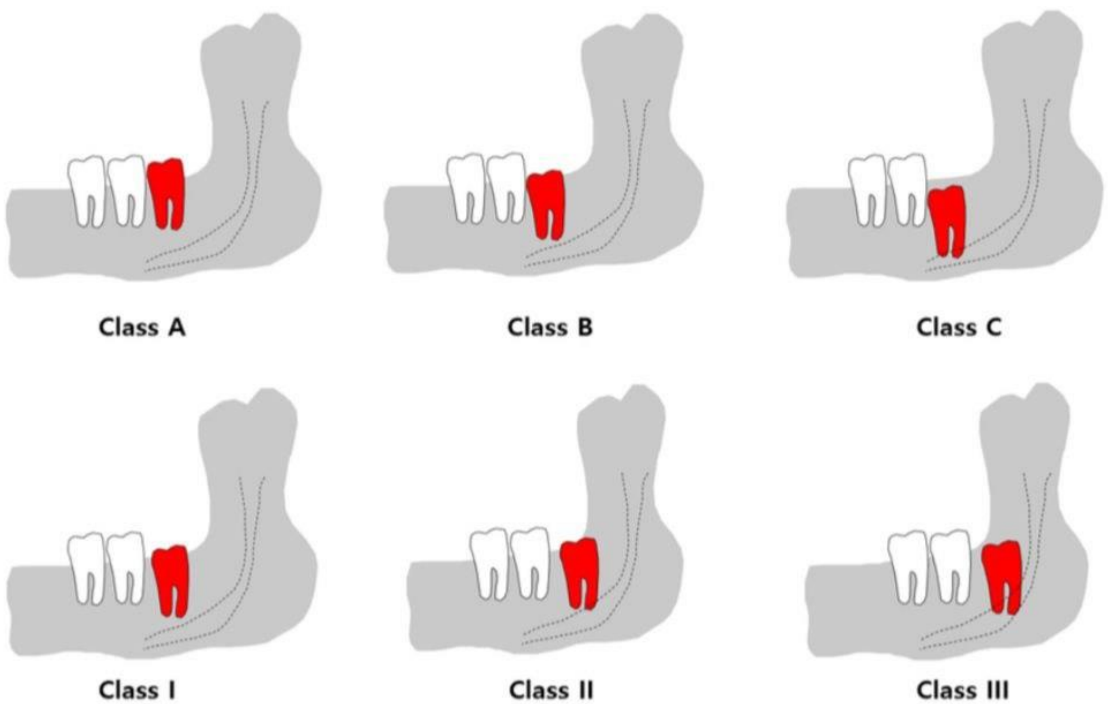

Figure (1.3) Pell and Gregory's classification **(Siddiqi et al., 2010) .**

3) Classification of impacted mandibular third molars according to the degree of coverage by overlying tissue (Latt et al., 2015)

1. **Soft tissue impaction**: The soft tissue can be dense and fibrous when the tooth is only covered by soft tissue and its largest bulge is higher than the alveolar bone that it surrounds.

2. **Hard tissue (bony) impaction:** when the tooth is covered by bone and its greatest bulge is below the level of the surrounding alveolus. This can be partial or complete bony impaction.

4) Pederson's index for assessment of the surgical difficulty

According to Pederson's index the difficulty of the operation was distributed into **3 levels:** slightly difficult, moderately difficult, and very difficult. Panoramic radiograph was used as a guide for determination of the IMTMs angulation according to Winter's classification, while depth and class according to Pell and Gregory's classification as shown in Table (1.2), **(Park, 2016).**

Classification	Value
Spatial Relationship	
Mesioangular	1
Horizontal/transverse	2
Vertical	3
Distoangular	4
Depth	
Level A: high occlusal level	1
Level B: medium occlusal level	2
Level C: low occlusal level	3
Ramus relationship/space available	
Class 1: sufficient space	1
Class 2: reduced space	2
Class 3: no space	3
Difficulty index	
Very difficult	7-10
Moderately difficult	5-6
Slightly difficult	3-4

Table (1.2) Pederson's difficulty index **(Gbotolorun et al., 2007)**

1.6.Pathological changes associated with impacted mandibular third molars

1. Pericoronitis

Pericoronitis is an inflammatory process caused by an infection of the gingival tissue around or overlying partially erupted tooth. Pericoronitis can be seen with any erupting teeth but most commonly associated with the eruption of mandibular third molars. Symptoms of pericoronitis can have a significant impact on the quality of daily life **(Kwon and Serra, 2021).**

2. Tumors and cysts associated to the third molar

Some patients with impacted third molars may develop odontogenic cysts or tumors, but these are rare **(Steed, 2014).** Many studies have found a broad range in the frequency of cysts and tumors surrounding impacted third molars **(Nordenram et al., 1987).**

3. Periodontitis

The incidence of periodontitis on the distal aspect of the second molar has been reported to vary from 1% to 5%. Older patients have a higher incidence of periodontitis relating to the impacted mandibular third molars because both the incidence and prevalence of periodontal diseases increase with age **(Grover and Lorton, 1985).**

4. Late crowding of the mandibular incisors

The main argument for prophylactical surgical removal of impacted mandibular third molars is the theory that their presence can lead to later crowding of the mandibular incisors. However, the development of crowding in the lower incisors was not seen to be significantly affected by the presence of impacted mandibular third molars in randomized controlled trials **(Richardson, 2002).**

1.7.Assessment of the impacted mandibular third molars

Assessment of impacted mandibular third molars is achieved by clinical and radiographic examinations.

1) Clinical assessment

Inspection and palpation of extraoral and intraoral regions include temporo-mandibular joint, angle of the mandible, muscle texture, tension, tongue size,contours and appearance, anterior teeth crowding, pain, and tenderness, limitation of mouth opening, soft tissue overlying the impacted mandibular third molars and the exposed portion of the partiallyimpacted tooth **(Khan et al., 2011)**.

2) Radiographic assessment

Radiographic evaluation is necessary to avoid complication and it can be done by conventional radiographs or by more advanced and specialized imaging techniques **(Costa and Assis, 2012).**

Evaluation of the size of follicular sac, roots morphology, bone density, relationship to the surrounding structures including second molar, inferior alveolar canal, ramus and body of the mandible **(Khan et al., 2011).**

Types of radiographs:

A. Periapical radiographs have many advantages as low radiation dose,, less magnification of dimensions and good quality **(Van Der Stelt, 2005).**

However, one of the most significant disadvantages of this approach, it illustrates a small area, high flexibility and processing artifacts of the periapical film, two-dimensions does not show the mandibular canal clearly and its relation to the mandibular third molar **(Juodzbalys and Wang, 2010).**

B. Occlusal radiograph is a true occlusal view and it gives all information of posterior teeth in cross section and is designed to capture what goes on inside the roof or floor of the mouth, which helps the dentist see full tooth development and placement **(Carol Mason et al.2001)**

C. Panoramic radiographs or orthopantomogram (OPG) are the method of choice when a wide region needed to be scanned in the third molar area, it provides broad coverage for the oral structures and it is relatively inexpensive. Panoramic radiographs still have disadvantages of low image resolution, high distortion, magnification, two-dimensions and overlapping with cervical structure **(Khan et al.,2011).**

D. Cone Beam Computed Tomography (CBCT): considered as the technique of choice when there is a need for three-dimensional evaluation for the impacted mandibular third molars and the surrounding anatomical structures **(Ghaeminia et al., 2011).**

CBCT imaging gives a clear idea about the bucco- lingual position and relationship to the inferior alveolar canal **(Matzen et al., 2013).**

The radiation dose of a CBCT is about 3-6 times to a panoramic radiograph (OPG) and 8-14 times to a periapical radiograph **(Signorelli et al., 2016).**

2.Definition of Juxta apical radiolucency

The juxta-apical radiolucency (JAR) is a recently described and still little-studied radiographic sign, it has been pointed out as an important predictor of IAN damage during third molar surgery **(Renton et al., 2005).**

The JAR appears as a hypodense area adjacent (juxta, meaning near, nearby, or close) to the apices and roots of mandibular third molars and has been considered a variation of the normal aspect of the trabecular bone in this region **(Umar et al., 2010).**

Nevertheless, a study using CBCT images to assess the JAR and mandibular canal reported that there is no definitive intimate relationship between these structures **(Kapila et al., 2014).**

Moreover, there is evidence that JAR is related to thinning of the cortical plates, which may be one of the factors leading to an increased incidence of IAN injuries as seen in figure (1.4), figure (1.5) and figure (1.6), **(Selvi et al., 2013; Kapila et al., 2014).**

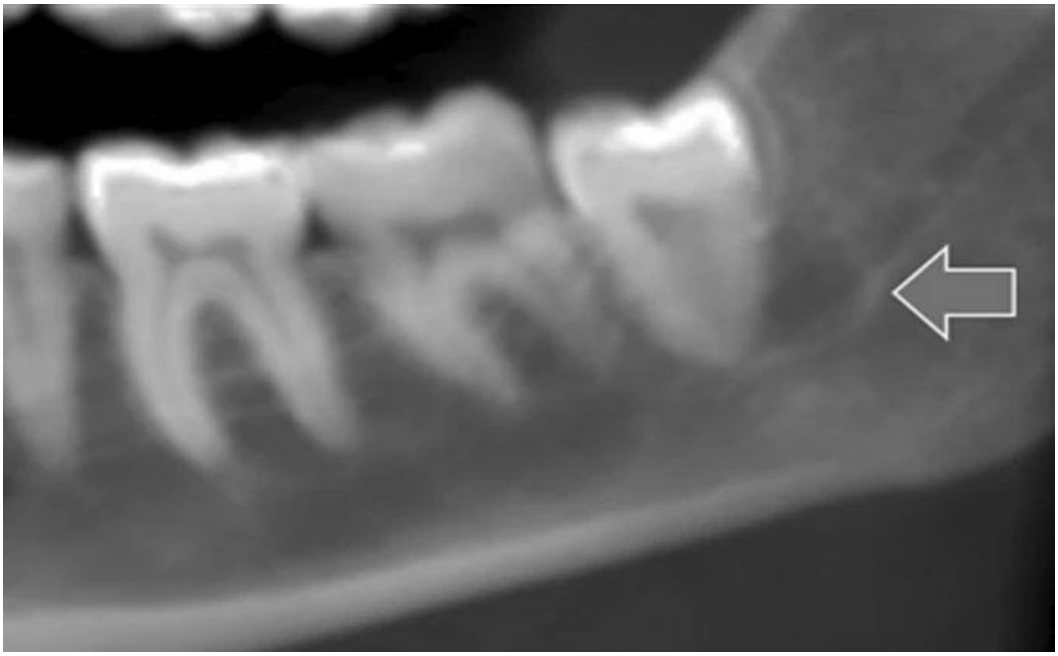

Figure (1.4) JAR associated with a lower third molar on reconstructed panoramic of CBCT images **(Mahvash et al, 2021).**

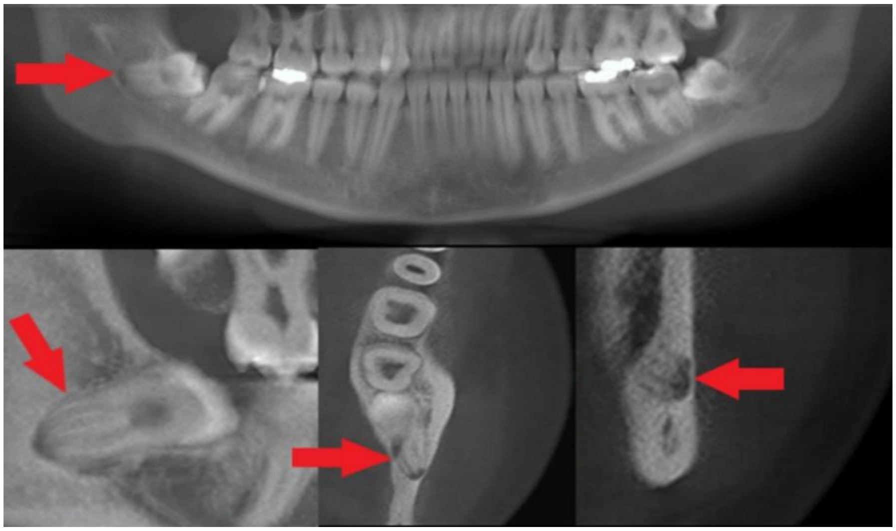

Figure (1.5) Multiplanar views of CBCT (Panoramic, sagittal, axial, coronal) show a juxta-apical radiolucency image (arrow), which appears as a well-circumscribed radiolucent area located laterally to the roots and continuously with the root apex of the third molar on the right side **(Sinem, 2021).**

Figure (1.6) Cropped panoramic radiograph shows a juxta-apical radiolucency image (arrow), which appears as a well-circumscribed radiolucent area located laterally to the roots and continuously with the root apex of the third molar on the right side **(Eduarda et al., 2017).**

2.1.Relation to the inferior alveolar nerve injury

Initially, we will discuss some important definitions in this aspect which is :

Dysesthesia which is a condition in which a sense, especially touch, is distorted. Dysesthesia can cause an ordinary stimulus to be unpleasant or painful. It can also cause insensitivity to a stimulus**.(Grant et al., 2000)**

Paraesthesia which is an abnormal touch sensation, such as burning or prickling, that occurs without an outside stimulus**.(Scully, 2014)**

Anesthesia which is a loss of feeling or awareness caused by drugs or other substances. Anesthesia keeps patients from feeling pain during surgery or other procedures. Local anesthesia is a loss of feeling in one small area of the body. Regional anesthesia is a loss of feeling in a part of the body, such as an arm or leg. General anesthesia is a loss of feeling and a complete loss of awareness that feels like a very deep sleep **(Pogrel, 2012).**

Neurotmesis which is an injury in which the nerve is completely divided. This results in complete paralysis, the resultant atrophy of muscles innervated by the nerve, and total anesthesia of the nerve's cutaneous distribution **(Hillerup and Jensen, 2006).**

Neurapraxia which is a disorder of the peripheral nervous system in which there is a temporary loss of motor and sensory function due to blockage of nerve conduction, usually lasting an average of six to eight weeks before full recovery. Neurapraxia is derived from the word apraxia, meaning “loss or impairment of the ability to execute complex coordinated movements without muscular or sensory impairment” **(Malamed, 2004).**

Surgical extraction of impacted mandibular third molars is a common procedure in dental practice.

To minimize the post-operative complications, the surgeon should have relevant information about the impacted third molars, such as the inclination of the tooth root/s to the buccal or lingual cortical plate and the course of the mandibular canal in relation to the roots.**(Harada et al., 2013)**

Panoramic radiographs are the imaging modality most commonly used by oral and maxillofacial surgeons to view impacted third molars and to estimate the risk of inferior alveolar nerve injury.**(Sedaghatfar et al., 2005)**

In particular, Rood and Shehab **(Rood and Shehab, 1990)** reported that three of seven classic radiographic signs indicate a higher risk of inferior alveolar nerve injury, implicating close proximity of the inferior alveolar nerve to the lower third molar.

Radiographic signs indicative of possible inferior alveolar nerve risk, as seen on panoramic radiographs include:
diversion of the canal, darkening of the root due to superimposition of mandibular canal, deflection of the root, narrowing of the canal and interruption of the canal lamina dura.**(Frafjord and Renton, 2010).**

However, some investigators have reported that panoramic radiography does not provide sufficiently reliable images to predict nerve lesions.**(Maegawa et al., 2003; Monaco et al., 2004; Sedaghatfar et al., 2005).**

In addition, some reports have indicated that it is only possible to determine the true relationship of the tooth root with the inferior alveolar nerve with CT.**(Maegawa et al., 2003; Monaco et al., 2004; Sedaghatfar et al., 2005; Umar et al. 2010).**

In fact, axial, coronal and sagittal CT images, all provide surgeons with useful information, and such images are also beneficial for the pre-operative planning of the surgical procedure because of the high-resolution quality of medical CT.**(Maegawa et al., 2003; Harada et al., 2013).**

It has been shown that cone beam CT (CBCT) images are best suited for pre-operative assessment of impacted third molars and the relationship of these to surrounding structures.**(Harada et al., 2013)**

A new radiographic sign, the juxta-apical radiolucency (JAR), has been seen on panoramic radiographs and has been shown to be more predictive of nerve injuries than that of other signs. This new radiographic sign is a well-circumscribed radiolucent area lateral to the root rather than at the apex.**(Renton et al., 2010).**
The presence of JAR has been related to a greater incidence of post-operative paraesthesia in some studies as seen in Figure (1.7), **(Renton et al., 2004; Hatano et al., 2009).**

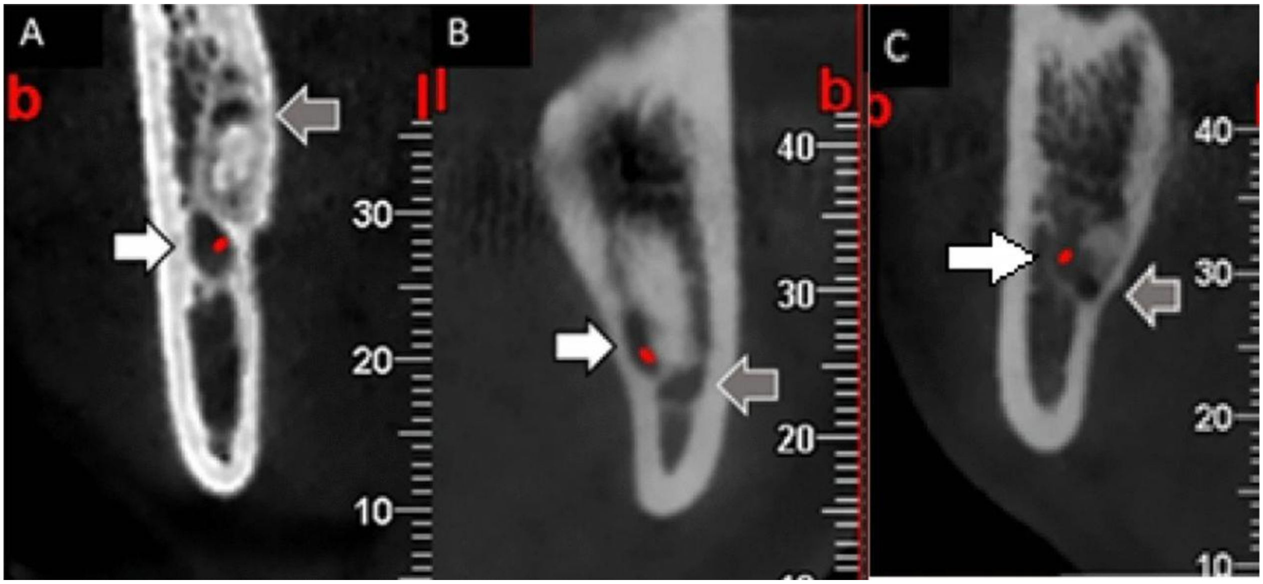

Figure (1.7) relation of JAR (gray arrows) to IAN (white arrows): distant (A); in contact with IAN with preservation of the cortical plate (B); and in contact with IAN without preservation of the cortical plate (C) **(Mahvash et al, 2021).**

The risk of nerve injury is evaluated based on radiographic evidence of an intimate anatomic relationship between the third molar and the inferior alveolar nerve canal. Validation studies **(Susarla and Dodson, 2007)** have shown that the panoramic radiograph as a test for nerve injury has a relatively low sensitivity (24°/o-38°/o) and a relatively high specificity (96°/o-98%). These studies indicate that, while there are discretely defined parameters on panoramic radiographs that are suggestive of nerve injury, only a minority of patients who sustain nerve injuries will have these signs. Conversely, the absence of these radiographic signs is of greater diagnostic utility for assuring a patient that they are at decreased risk for inferior alveolar nerve injury **(Susarla and Dodson, 2007).**

However, there is no agreement on which of the radiographic signs described in the literature are the most reliable to show an anatomic relationship between the molar roots and the mandibular canal. The detection by CT of an intimate contact between the lower third molar roots and the mandibular canal has been associated with a higher risk of exposure of the neurovascular bundle during surgery and seems to be associated with a higher risk of inferior alveolar nerve injury. There are still no clear guidelines that can be used to indicate a CT/CBCT exploration for third molar extractions, and the debate is still open **(Kapila et al., 2014).**

Monaco et al. recommended such exploration when there are two or more radiographic signs of proximity between the mandibular canal and the roots of the third molar and deep impaction and horizontal position of the third molar. There are more chances of inferior alveolar nerve injury in patients with "higher" mandibular canals (which could be classified as "deeper impaction") **(Monaco et al., 2004).**

Maegawa et al. recommended CT examination when the panoramic radiograph shows the following conditions:

(1) a root apex at the lower half or under the inferior wall of the mandibular canal; or (2) the white line, indicating the border of the mandibular canal is not seen clearly **(Maegawa et al., 2003).**

However, Better et al. pointed out that the data obtained from CT scans have a minimal effect on the final surgical outcome or morbidity, and their routine use cannot be recommended **(Better et al., 2004).**

On the other hand, there is low positive-predictive value of the orthopantomogram in detecting patients at risk of inferior alveolar nerve injuries after the third molar extraction, as most patients classified as high risk based on orthopantomographic findings do not sustain such complications **(Sanmarti et al., 2012).**

It has been seen that direct exposure of the neurovascular bundle and/or a contact relationship between the tooth and the inferior alveolar nerve on CT increases the incidence of injury to the inferior alveolar nerve (IAN) by approximately 20%-30%. **(Nakamori et al., 2008).** In another study, dysaesthesia was seen in a patient with the presence of pre-operative JAR, when subjected to coronectomy **(Hatano et al., 2009).**

2.2.Relation to the mandibular canal and cortical plates

Several studies indicate that JAR was significantly associated with lingual positioning of the mandibular canal. This may be of clinical relevance, since some studies have reported a higher risk of injury (**Ghaeminia et al., 2009; Kim and Lee, 2014)** or exposure **(Ghaeminia et al., 2009; Nakayama et al., 2009; Neves et al., 2012; Hasegawa et al., 2013)** of the IAN in cases in which the mandibular canal runs lingually to the third molar.

This could be explained by the fact that unfavorable forces are generated and propagated in a lingual direction, although the majority of surgeons usually perform the procedure using a vestibular approach **(Ghaeminia et al., 2009).**

Another important factor that may be associated with an increased incidence of transsurgical and postoperative complications secondary to third molar removal is the direct contact between the JAR and the mandibular canal, which was identified in 28.6% of the cases in some studies (contact without cortical border preservation) **(Kapila et al., 2014).**

There is evidence that a direct relationship between the tooth and the mandibular canal (lack of cortical preservation of the mandibular canal) greatly increases the risk of nerve injuries **(Nakayama et al., 2009; Hatano et al., 2009; Neves et al., 2012).**

However, whether direct contact of the JAR with the nerve produces the same effect is unknown. It may be justifiable to believe that contact between the JAR and the mandibular canal, either with or without cortical preservation, could produce a fragile area in the region of the mandibular canal that would leave the IAN more susceptible to injuries.

Kapila et al. **(Kapila et al., 2014)** found at least some degree of thinning in 70% of their cases. These authors compared the thinning caused by JAR with the thinning caused by the third molar/mandibular canal in a control group and found a significant association between cortical thinning and JAR.

Although it has been suggested that cortical thinning may be related to an increased incidence of paresthesia after third molar extraction, **(Kapila et al., 2014)** the study highlight other potential complications, such as risk of herniation of tooth fragments into the lingual fossa when the lingual cortical plate is substantially thinned **(Umar et al., 2010).**

Although JAR position does not influence its relationship with the mandibular canal or cortical thinning, knowing the location of JAR is important because this area may require special attention during surgical procedures. Kapila et al. **(Kapila et al., 2014)** evaluated the position of JAR relative to the mandibular canal and found that the buccal position was more prevalent, followed by the superior position.

The buccolingual position and the actual relationship of the JAR with the mandibular canal have been assessed via tomography images, which allow 3-dimensional reconstructions that avoid overlapping and distortion of anatomic structures**(Tantanapornkul et al., 2007; Ghaeminia et al., 2009; Umar et al., 2010; Hasegawa et al., 2013).**

The additional information provided by CBCT may help professionals to decide, for example, the approach or surgical technique (extraction or coronectomy) that will be most likely to prevent nerve injury **(Renton et al., 2005; Hatano et al., 2009; Umaret al., 2010).**

Despite the increasing interest in this entity, the origin of JAR is still unknown. Renton **(Renton, 2010)** indicated that the JAR might be an extension of the inferior alveolar nerve lamella with the dental lamina dura

However, Kapila et al. **(Kapila et al., 2014)** assessed JAR in CBCT images and were able to clearly locate and differentiate the JAR and the mandibular canal. Another study using CBCT suggested that JAR radiographic characteristics were related to those of a large cancellous bone space, implying that JAR is a superimposition of the canal over these spaces **(Umar et al., 2010).**

The study believe that JAR is indeed an image created by increased separation of the trabeculae in cancellous bone, but it is not necessarily associated with the mandibular canal. However, the literature offers no explanation of the timing of onset of JAR or its changes in form and size over time. The associations found here highlight the importance of identifying JAR before surgical removal of mandibular third molars. The results seem to confirm that JAR is related to risk factors for inferior alveolar nerve injuries and reinforces the role of CBCT in the assessment of these patients. Therefore, knowing the relationship of JAR to adjacent structures (tooth, mandibular canal, and cortical plates) on an individual basis is important in guiding professionals during surgical planning and patient management. (Figure 1.8), (Figure 1.9), (Figure 1.10) and (Table 1.3) ,**(Renton et al., 2005; Hatano et al., 2009).**

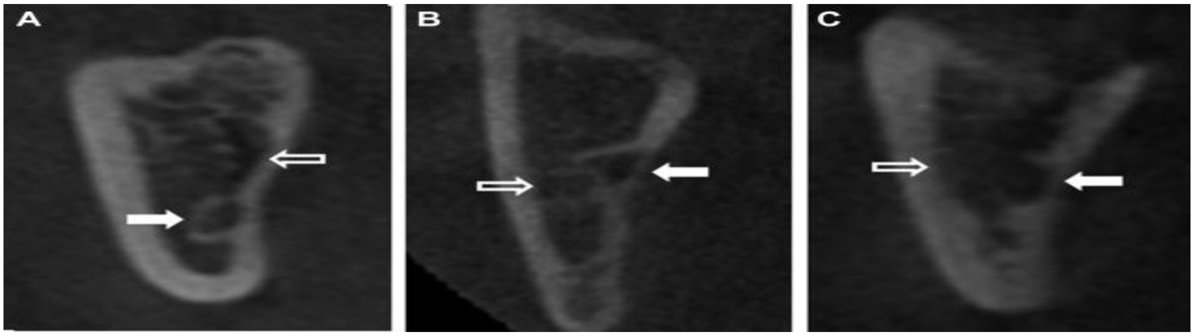

Figure (1.8) Cone beam computed tomography images showing the anatomic relationship between juxta-apical radiolucencies (unfilled arrows) and the mandibular canal (filled arrows) **(Eduarda et al., 2017).**

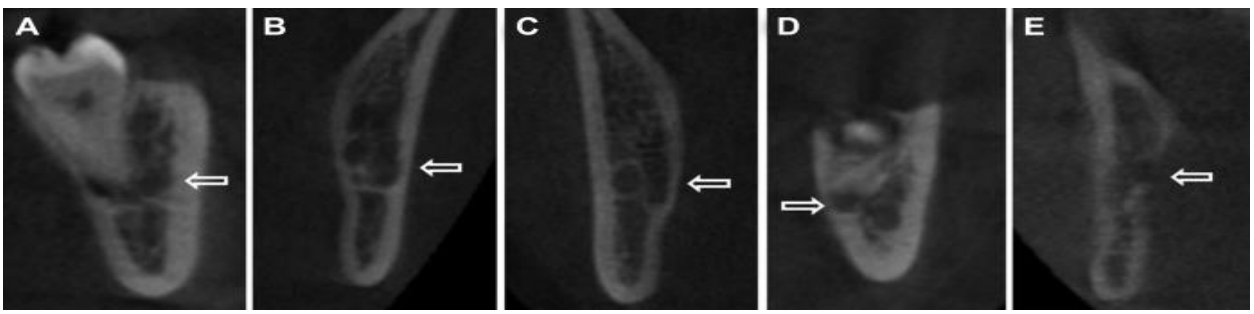

Figure (1.9) Cone beam computed tomography images showing the relationship between juxta-apical radiolucencies (arrows) and thinning of the cortical plates according to the classification proposed by Kapila et al.13 **(Kapila et al., 2014).**

J1	When the remaining thickness of the cortical plate was two-thirds of the maximum thickness
J2	When the remaining thickness of the cortical plate was one-half of the maximum thickness
J3	When the remaining thickness of the cortical plate was one-quarter of the maximum thickness

Table (1.3) Classification for thinning of cortical plates **(Kapila et al., 2014).**

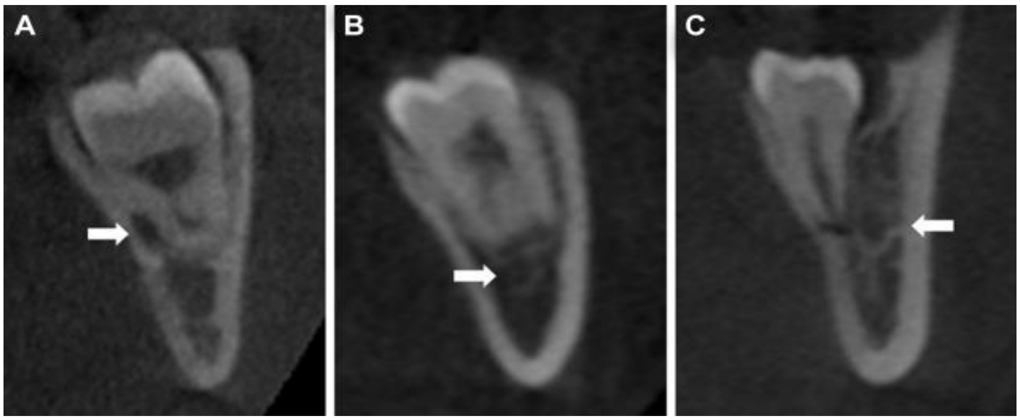

Figure (1.10) Cone beam computed tomography images illustrating the position of the mandibular canal in relation to the third molar roots (arrows). (A) Lingual position. (B) Apical position. (C) Buccal position **(Eduarda et al., 2017).**

CHAPTER THREE : CONCLUSION

Conclusion

CBCT imaging for JAR assessment provides insights into the relationship of JAR with the mandibular canal and the mandibular cortical plates. In most JAR cases, the mandibular canal is positioned lingual to the third molar and contacts the JAR. Both situations may increase the risk of nerve injury during removal of mandibular third
molars when JAR is present.

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