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University of Baghdad
College of Dentistry

Evaluation of Relative Position of Mandibular Foramen in Iraqi sample as a Reference for Inferior Alveolar Nerve Block using Panoramic Radiograph
(Retrospective Study)

A project submitted to the College of Dentistry, University of Baghdad, Department of Oral Diagnosis in partial fulfillment for the requirement to award the degree B.D.S.

By
Diyar Ali Mohsin
Fifth Grade

Supervised by
Assistant Lecturer Dr. Farah Abdul-Salam
Oral and Maxillofacial Radiology
B.D.S., M.Sc.

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بسم الله الرحمن الرحيم

صدق الله العظيم

سورة يوسف (الاية 76)

Dedication

This Project is dedicated to my family,

Dear grandfather & grandmother

To my lovely father & mother

And my supervisor

For their endless love, support & encouragement

Abstract

Background:

The mandibular foramen is an opening on the internal surface of the ramus for divisions of mandibular vessels and nerve to pass. The knowledge of mandibular foramen position & it's exact localization is very essential for both diagnostic & clinical purposes.

Aim of the study:

To assess the relative position of the mandibular foramen according to the site , gender & it's relationship with distances from the anterior border of ramus & from the mandibular occlusal plane in Iraqi subjects sample .

Materials and Methods:

A retrospective study consists of thirty (30) Iraqi subjects with age ranged from (18-35) years old specialized private center for dentistry in Baghdad city, taking panoramic radiographs for different diagnostic purposes.

The study sample was divided into the following three groups according to the age:-

Group1 (18-23)
Group2 (24-29)
Group3 (30-35)

Also it was divided into two groups according to the gender.

Results:

This survey was a retrospective study carried out on 30 Iraqi subjects between the age of 18 and 35 years old taking panoramic radiographs.

These subjects were subdivided into groups according to the age, and the side of the jaw.

The sample included 17 male (56.7%) and 13 female (43.3%) respectively.

The subjects were divided into three groups according to age. It was observed that 10 cases in the age group of 18-23 years (33.3%) , 9 cases in the age group of 24-29 years (30%) and 11 cases in the age group of 30-35 years (36.7).

Conclusion:

There was a gradual increase in mandibular foramen mean distance from anterior border of ramus & above the occlusal plane in Group1, Group2, Group3.

The mandibular foramen position is not bilaterally symmetrical for any of the considered age groups.

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List of abbreviation

Symbol	Abbreviation
TMJ	Tempromandibular joint
IAN	Inferior Alveolar Nerve
IANB	Inferior Alveolar Nerve Block
MF	Mandibular Foramen
ML	Mandibular Lingula
OP	Occlusal Plane
AB of Ramus	Anterior Border of Ramus
G	Group
%	percentage
PR	Panoramic radiography
DR	Digital radiography
CCD	Charged coupled device
CMOS/APS	Complementary metal oxide semiconductors/ active pixel sensor
CID	Charged injection device
OPG	Orthopantomogram
No./N	Number
Min	Minimum
Max	Maximum
Yrs	Years
SD	Standard deviation
R	Right
L	left
mm.	Millimeter

Introduction

The mandible is the most inferior structure of the skull. It consists of body of mandible anteriorly and ramus of mandible posteriorly. These two structures meet together posteriorly at the angle of the mandible (Grays, 2009).

It is considered as the largest and strongest bone of the face which articulate with the skull at the temporomandibular joint (TMJ) (Snell, 2007).

It is a U shaped bone which completes the skull and it is the only mobile bone of facial skeleton (Jahan-Parwar, 2009).

The mandibular foramen (MF) is an opening on the internal surface of the ramus for divisions of the mandibular vessels and nerve to pass. The mandibular canal starts at the MF and descends obliquely forward in the ramus, and later in the body of bone containing the inferior alveolar neurovascular bundle (Narayana K et al, 2005)

The importance of prediction of the exact position of MF is that pain control is an important aspect in behavior management of dental patients. Local anesthesia is still a widely used technique for pain control in dental treatment. For anaesthetizing mandibular teeth, the inferior alveolar nerve has to be blocked. The landmarks considered for IANB are the external oblique ridge, coronoid notch, pterygomandibular raphe and the occlusal plane on the ipsilateral side . The mandibular foramen present on the medial aspect of mandibular ramus is protected anteriorly by a bony tongue like protrusion known as mandibular lingula . By following these landmarks the anesthetic solution is delivered as close as possible to the mandibular foramen. However the mandibular foramen location shows variation among people of different ethnicity, age and even within the same individual on two sides.(McDonald et al,2014; Malamed,2012; Langlais et al,1985)

Panoramic radiography is a radiological technique for producing single image of the facial structures that include both the maxillary and mandibular dental arches and their supporting structures (Haring and Jansen, 2000).

This technique is most useful clinically for diagnostic problems requiring broad coverage of the jaws. Common examples include evaluation of trauma, third molar, extensive disease, unknown or suspected large lesion, tooth development (especially in mixed dentition), retained teeth or root tips (in edentulous patients) and developmental anomalies. These tasks do not require the high resolution and sharp detail available on intraoral radiographs (White and Pharoah, 2000).

Digital radiography has been revolutionizing dentistry since its introduction two decades ago in 1987 (Wenzel, 2002). This technology uses a sensor, computer and a monitor to acquire, process, store retrieve and display the radiographic image. In some cases a scanner is required. In digital radiography, the image is more like a mosaic, tiny pieces put together to make the final portrait. These tiny dots of information, called pixels, are short for “picture elements” (Bushong, 2001; Marrow, 2006).

The purpose of digital radiography is to generate images that can be used in the diagnosis and assessment of dental disease. Similar to film based radiographic procedures; digital radiography allows the radiographer to obtain a wealth of information about the teeth and supporting structures (Iannuccin and Howerton, 2006).

Aim of the Study:

To assess the relative position of the mandibular foramen according to the age , site & it's relationship with distances from the anterior border of ramus & from the mandibular occlusal plane in Iraqi subjects sample .

Chapter one

Review of literature

Review of literature

1.1. Anatomy of Mandible

The lower jaw is the most inferior structure of the skull. It consists of body anteriorly and ramus posteriorly. These two structures meet together posteriorly at the angle of the mandible (Grays, 2009).

It is considered as the largest and the strongest bone of the face which articulate with the skull at the temporomandibular joint (Snell, 2007).

It is a U shaped bone which completes the skull and it is the only mobile bone of facial skeleton (Jahan-Parwar, 2009).

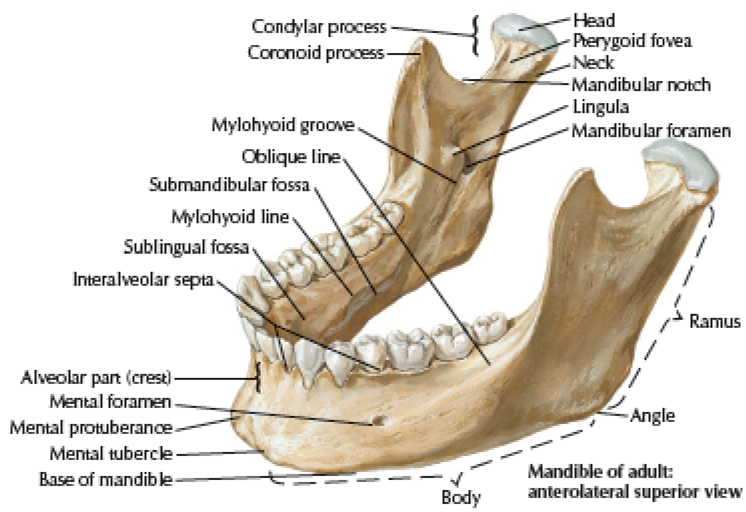


Figure (1-1) Anatomy of the Mandible (Netter , 2012)

1.1.1. Body of the Mandible

The body is somewhat curved like a horse shoe and has two surfaces, these surfaces are:

A- The external surface which is marked by a faint ridge, indicating the symphysis. This ridge divides below and encloses a triangular eminence, the mental protuberance, the base of which is depressed in the center but raised on either side to form the mental tubercle. On either side of the symphysis, just below the incisor teeth, there is a depression, the incisive fossae which gives origin of mentalis and portion of orbicularis oris muscle. Below the second premolar tooth on both side of the body of mandible is the mental foramen, running backward and upward from each from each mental tubercle a faint ridge the oblique line which is continuous with anterior border of mandible which provides attachment to the quaderatous labii inferioris and triagularis; the platysma attached below it (Grays, 2009).

B- The internal surface which is concave from side to side, near the lower part of the symphysis there is a pair of laterally placed spines, mental spine, which give the origin of genioglossi. Extending upward and backward on either side from the lower part of the symphysis is the mylohoid line, which gives origin of the mylohyoideus (Grays, 2009).

The body of mandible is divided into two parts: (Snell 2007).

1- The lower part is the base of the mandible.
2- The upper part is the alveolar part of the mandible which contains the teeth.

1.1.2. Ramus of the Mandible

The ramus of the mandible is quadrangular in shape and has medial and lateral surfaces; the lateral surface is generally smooth except from few obliquely oriented ridges for attachment of masseter (Grays, 2009). On the medial surface there is the mandibular foramen. In front of the foramen is a projection of bone called linguala for attachment of sphenomandibular ligament.

The foramen leads to the mandibular canal which opens on the lateral surface of the body of mandible at the mental foramen. The incisive canal is a continuation forward of the mandibular canal beyond the mental foramen and below the incisor teeth (Snell, 2007).

The lower border of ramus is thick, straight, and continuous with the inferior border of the body of mandible; by this junction it forms the angle of mandible. The ramus of mandible is vertically places and has an anterior coronoid process and a posterior condyle process; the two processes are separated by the mandibular notch (Netter, 1989).

1.2. Mandibular Foramen

The mandibular foramen (MF) is an opening on the internal surface of the ramus for divisions of the mandibular vessels and nerve to pass. The mandibular canal starts at the MF and descends obliquely forward in the ramus, and later in the body of bone containing the inferior alveolar neurovascular bundle (Narayana K et al, 2005)

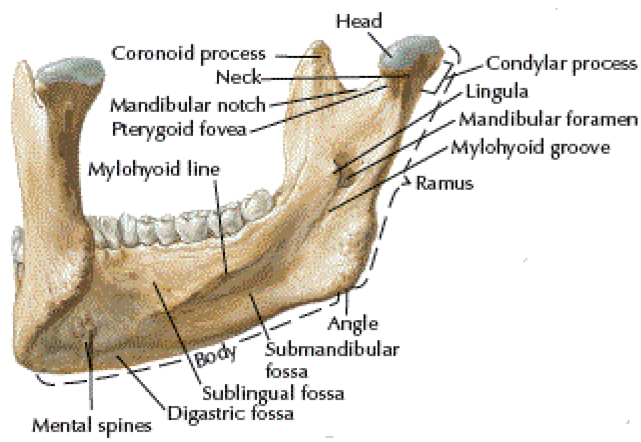


Figure (1-2) Mandibular Foramen and Lingula (Netter, 2012)

1.2.1. Mandibular Lingula

Lingula is a tongue-like flap of bone that overlaps the mandibular foramen antero-medially and location is clinically significant in oral and maxillofacial surgeries. Is a triangular bony projection or ridge on the medial surface of the ramus of the mandible, immediately superior to the mandibular foramen. It provides attachment for the sphenomandibular ligament. (Churchill, 2008)

Proper evaluation of the anatomical landmarks in relation to the IAN, such as the MF and ML, is the key to the achievement of effective anesthesia of the IAN in clinical practices of the mandible. (Archer WH, 1975)

1.3. Mandibular Nerve

The mandibular division of the trigeminal exits the skull through the foramen ovale and then divides into the anterior and posterior divisions with the main nerve trunk below the foramen. The trunk gives two branches, namely a) the nerve to medial pterygoid muscle and b) a meningeal branch which goes back to the cranium through the foramen spinosum; this branch is also called the nervus spinosus(Malamed,2012).

The mandibular nerve then divides in to two divisions, anterior and posterior. The anterior division of the mandibular nerve has mainly motor branches and the motor nerves of this division comprise the nerve to the temporalis muscle, nerve to the lateral pterygoid, and nerve to masseter muscles. The buccal nerve is the sensory branch of the anterior division (also known as the long buccal nerve and the buccinators nerve). The buccal nerve does not supply the buccinators muscle, but this muscle gets its innervation from the facial nerve. The posterior division of the mandibular nerve is mainly sensory. Branches of the posterior division are the lingual nerve, inferior alveolar nerve, and auriculotemporal nerve (Somayaji et al, 2012)

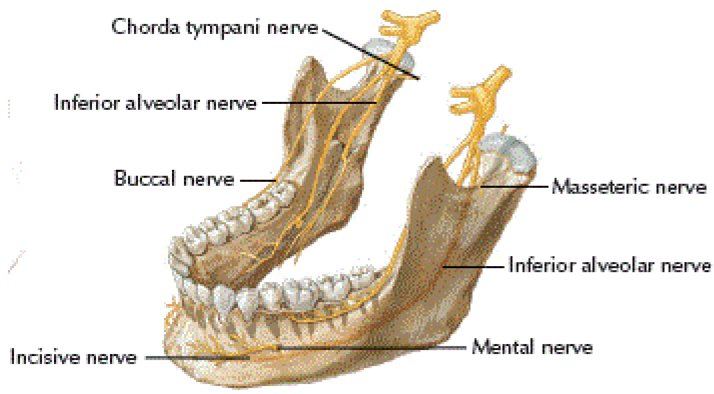


Figure (1-3) Divisions of Mandibular Nerve (Netter, 2012)

1.3.1. Inferior Alveolar Nerve Block

The inferior alveolar nerve block is the most common technique used in dentistry. Despite its importance, it is associated with a failure rate of 15-20% a figure which represents the highest percentage of all clinical failures achieved using local anesthesia (Malamed, 2012)

Successful inferior alveolar nerve block is related to the deposition of local anesthetic material very close to the nerve before it enters the mandibular foramen. Some researchers have shown that anesthesia of the inferior alveolar nerve block can also be achieved by the deposition of anesthetic material in the pterygomandibular space as the result of diffusion of the material toward the area of the mandibular foramen(Takasugi Y et al,2000)

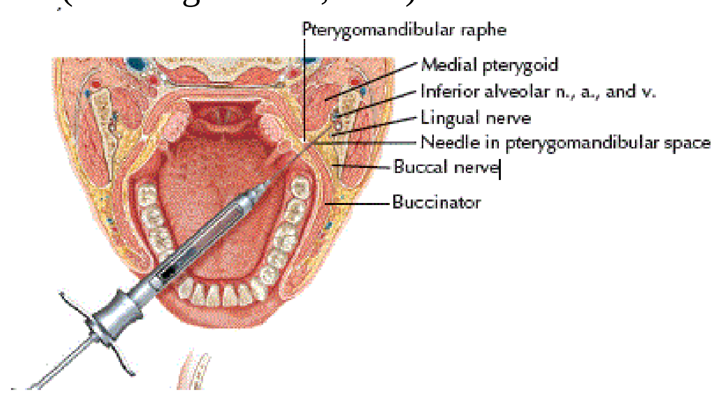


Figure (1-4) Inferior Alveolar Nerve Block (Netter , 2012)

1.3.1.1. Complication of Inferior Alveolar Nerve Block

Complication related to the inferior alveolar nerve block vary from being common to rare, and include **(**Smyth and Marley, 2010; Ethunandan et al, 2007; Chevalier, 2010):

1. pain and trismus produced by tearing the mucosa during insertion or even by the withdrawal of the needle
2. needle breakage at that point of injection
3. facial paralysis caused by deposition of the anesthetic solution in the parotid region
4. Hematoma
5. necrosis of the skin of the chin
6. diplopia, and abducent nerve palsy
7. ptosis and extraocular muscles paralysis
8. Some rare complications include a reduction in visual acuity and atrophy of the optic nerve. It has been also reported recently that inferior alveolar nerve block could be a factor in third molar agenesis

1.4. Prediction of MF position and its importance

Pain control is an important aspect in behavior management of dental patients. Local anesthesia is still a widely used technique for pain control in dental treatment. For anaesthetizing mandibular teeth, the inferior alveolar nerve has to be blocked. The landmarks considered for IANB are the external oblique ridge, coronoid notch, pterygomandibular raphe and the occlusal plane on the ipsilateral side. The mandibular foramen present on the medial aspect of mandibular ramus is protected anteriorly by a bony tongue like protrusion known as mandibular lingula. By following these landmarks the anesthetic solution is delivered as close as possible to the mandibular foramen. However the mandibular foramen location shows variation among people of different ethnicity, age and even within the same individual on two sides. (McDonald et al, 2014; Malamed, 2012; Langlais et al, 1985)

1.5. Panoramic Radiography

Panoramic radiography is a radiological technique that produces a single image of the facial structures including both maxillary and mandibular dental arches and their supporting structures (Haring and Jansen, 2000).

The development of PR equipment represented a major innovation in the field of dental imaging as prior to this dental radiographic image consisted solely of intraoral and oblique lateral projection of jaw taken using a conventional dental X-ray set (Staley, 2001; Akcam et al., 2003).

This technique is most useful clinically for diagnostic problems requiring broad coverage of the jaws. Common examples include evaluation of trauma, 3rd molar, extensive disease, suspected large lesion and tooth development. These tasks do not require the high resolution and sharp detail available on intraoral radiographs (White and Pharoah, 2000).

In addition to the above uses of PR, several researchers (Thomas et al., 2001; Roberts, 2005; Laskin, 2009) mentioned a number of indications such as:

1. It is used in orthodontics to evaluate the tooth axial inclination, maturation and condition of the surrounding tissues.
2. Linear and angular measurements of the mandible such as gonial angle.
3. It's used in implant both preoperatively to locate the anatomical land mark for proper positioning of the implant, and postoperatively to monitor patient healing and possible bone loss.
4. Detection of occlusal caries.

In the early part of the 20th century, many researchers were developing techniques using movement of the X-ray tube and the film in order to visualize structures or foreign bodies situated within patient.

Future researches resulted in development of x-ray equipment using two quite different radiographic techniques to produce an overall image of the jaws.

One group of researchers developed a small x-ray source which when positioned intraorally, would directly expose a film molded outside the patient's head. The other group relied upon the production of a tomographic image of the jaw with the tube positioned extra orally combined with an either intraorally or extra orally placed film (Rushton and Route, 2006).

Numata in 1993 constructed a suitable device for the clinical examination of the jaws. Numata prototype used a very narrow collimated beam of x-ray photon, often referred to as a slit beam. The x-ray equipment rotated around the patient head and the film positioned intraorally in the lingual sulcus.

In 1946, Dr. Yajo Veli Paatero introduced a unit similar to that introduced by Numata in 1993. Paatero's prototype positioned the film intraorally requiring separated film for each jaw. The equipment used a stationary slit x-ray beam which scanned the teeth and the jaws manually rotating the patient around an x-ray source as the patient sat in the dental chair. Further research by paatero in 1949 resulted in the development of a single axis or concentric rotational panoramic system; this system incorporated a curved extra oral film cassette rather than the time consuming and uncomfortable intraoral placement of the image receptor. The equipment continued to use a slit collimated x-ray beam with the patient and the curved extra oral film cassette rotated around a stationary x-ray source, with the film exposed through a vertical slit. The method of exposure consisted of the rotation of the patient around in front of a stationary x-ray tube as the film was translated behind the vertical slit to achieve a sequential exposure (Rushton and Rout, 2006).

In 1954, Paatero worked in collaboration with Dr. Sidney Blackman and Watson and Sons Ltd. to develop a commercial model of panoramic unit known as "Rotograph". With the aid of this apparatus, a radiograph of both the upper and lower jaws from one temporomandibular joint to the other could be made in a single exposure on one film without causing patient discomfort. The body of the mandible is unfolded and is shown in one plane including both ascending rami. The image is formed by rotating the patient and the cassette simultaneously in one direction and the x-ray source in opposite direction. These developments have made a major contribution to panoramic radiology; the introduction of the digital imaging later on has made the most striking impact upon dentist (Rushton and Route, 2006).

1.5.1. Advantages and disadvantages of PR:-

Panoramic radiography has several advantages and disadvantages as this was stated by (**white and Pharoah, 2000; Moore, 2001; Iannucci and Howerton, 2006; Whaite, 2007**):

A- Advantage of PR:

1- Broad anatomical coverage.
2- Low dose of radiation.
3- Short imaging time which is less than 2 to 3 minutes.

4- Comfortable technique and well tolerated by the patient as the film is not placed intraorally.
5- Reliable screening tool and effective for patient education.

B- Disadvantage of PR:

1- High initial cost of the system which may be two to four times that of an intraoral x-ray generator (Goas and white, 1994).
2- Less resolution as compared to the intraoral radiography because it's an extra oral technique.
3- Less sharpness and lacks fine anatomical details therefore it's a good screening tool for detection of larger changes in dentition and bone.
4- Superimposition, magnification, geometric distortion and overlapping of the structures, therefore it's inadequate for detection of interproximal caries due to interproximal overlap. Occasionally presence of overlapping structures such as ghost of the cervical spine can obscure area of interest particularly in the lower anterior region.
5- Patient positioning errors cause the image distortion and ghost images which will obscure useful information and compromise useful diagnosis.

1.5.2. Digital radiography (DR):

Digital radiography has been revolutionizing dentistry since its introduction two decades ago in 1987 (Wenzel, 2002). This technology is gaining in popularity and in the past five years, the use of DR has more than doubled from 10% in 2000 to 22% in 2005 (Russo et al., 2006).

This technology uses a sensor, computer and a monitor to acquire, process, store retrieve and display the radiographic image. In some cases a scanner is required. In digital radiography, the image is more like a mosaic, tiny dots called pixels, which are short for "picture elements" put together to make the final portrait (Bushong, 2001; Marrow, 2006).

Most digital systems use a conventional dental x-ray unit as the source for radiation. Besides the required computer and monitor, basic components of digital system include imaging software, image recording device and scanner if needed (Iannuccin and Howerton, 2006).

The purpose of digital radiography is to generate images that can be used in the diagnosis and assessment of dental disease. Similar to film based radiographic procedures; digital radiography allows the radiographer to obtain a wealth of information about the teeth and supporting structures that can't be detected clinically. Uses of DR include the following: - (Iannuccin and Howerton, 2006).

1- To detect lesion, disease and conditions of the teeth and surrounding structures.
2- To provide information during dental procedures (e.g. surgical placement of implant).
3- To evaluate growth and development.
4- To illustrate changes secondary to caries, periodontal disease or trauma.

There are three basic means to acquire the digital image:-

1- **Direct: -** this is the fastest method to acquire an image and require a specially coated electronic receptor, called a sensor which is placed in the mouth in a similar manner as the film packet. When exposed to radiation, the sensor converts the x-ray to an electronic form which is read by the computer almost immediately. Intraoral sensor are comparable in size to an intraoral film packet and may be wired or wireless. Wired sensor connected to the computer via fiber optic cable and wireless sensor communicates with the computer via a radiofrequency (Morner, 2002). The sensor is a charged coupled device (CCD), it consist of silicon crystal arranged in a lattice and converts light energy into an electronic signals.

   The greatest advantage of the direct system is gain in time and the image is directly projected on the computer screen. Originally active areas of the sensor were smaller than conventional film which increase the incidence of conning off and require repeated exposure to capture all the desired information. Recent innovations have produced sensors approaching or equal to the standard film size (Brennan, 2002). In addition to CCD another sensor technology that is considered as a direct system which is complementary metal oxide semiconductors/ active pixel sensor (CMOS/APS) which has a 25% greater resolution, less expensive and greater durability than CCD. While the other sensor technology is the charged injection device (CID) which is silicon based solid state imaging receptor similar to CCD; however it differs structurally from CCD. This system consists of a CID x-ray sensor, cord and plug that are inserted into Reveal light source on the camera platform; digital images will be seen on the system monitor within seconds and no computer is needed to process the images. The image can be printed with a color video printer and saved as a computer file or onto a video disk recorder (Iannucci and Howerton, 2006).

2- **Indirect: -** this is the slowest method and requires a conventional dental radiograph. The film based radiograph is converted into a digital image using an x-ray film scanner with a transparency adaptor option and transferred to a computer for display and storage. A digital still or video camera can be used to take a photograph of the dental radiograph. The resulting image is considered to be a copy of the original (Brennan, 2002).

3- **Semi direct system: -** it involves the use of a phosphor storage plate PSP. This plate stores energy after exposure to radiation and emits light when scanned by laser. Loading of the scanners generally only requires subdued lighting as the plates are slightly sensitive to visible light but some products are more sensitive to light than others. The lasers used are centered around the 600-nm band and are usually of helium-neon variety.

The plate can store energy for days but the information start to be lost within minutes after exposure and it is advised to scan the plate quickly to optimize the image recovered. The image plates are available in exactly the same size as conventional film and come with disposable plastic barriers. They have no wires attached and are reusable for thousands of exposures but needs careful handling to avoid surface damage (Brennan, 2002).

1.5.2.1. Advantages and disadvantages of DR:-

(**Godfredsen et al., 1991; Brennan, 2002; Christensen, 2004; Firestone, 2004; Iannucci and Howerton, 2006)** have summarized the advantages and disadvantages of DR and as follow:

Advantage of DR:

1- Immediate observation of the radiographic images:- CCD provide immediate viewing, while the phosphorous plate technology requires the placement of the irradiated sensor in a processing device to scan it and put the information into a computer so that the image can be viewed but even with this its still faster than the conventional radiography. This has a significant clinical advantage in many oral procedures such as implant surgery.

2- Less radiation: - the reduction of radiation dose by DR usually 70-80% and sometimes reduction may reach up to 90% as compared to E-speed film. This reduction of radiation dose is important in implant placement in which multiple images needed frequently.

3- Loss of conventional films, while with DR there is no reason to lose stored digital radiographic image, assuming adequate back up procedures. Storage was initially a problem before the development of DVDs and CD ROMs, three periapical images would fill a floppy disk, however, now CD ROM can hold over 30000 images.

4- Superior gray scale resolution: - the DR uses up to 256 shades of gray compared with the 16 to 25 shades seen on conventional films. This allows for contrast and density enhancement, which aids in the detection of the disease.

5- Image manipulation: - this is the greatest advantage of digital imaging over conventional film. It involves selecting information of greatest diagnostic value and suppressing the rest. Manufactures provide software programmer with many different processing tools and these include :-

A- Contrast enhancement: - this can effectively compensate for over or under exposure of the digital image.

B- Measurements: - digital calipers, rulers and protractors are some of the many tools available for image analysis.

C- Three d construction: - to visualize the structures in all three dimensions.

D- Filtration: - the addition of filters to the air space around the face can clarify the soft tissue profile if the original soft tissue image was poor.

6- Eco-friendly: - no film, dark room, chemicals or processing equipment needed. Both CCD sensor and the PSP plate are capable of being reused for many thousands of exposures.

7- Patient education: - leads to increased patient's understanding of their oral condition.

Disadvantage of DR:-

1- Initial setup cost: - the initial cost of purchasing a digital imaging system is a significant disadvantage, also service and maintenance for any repair must be considered.

2- Image quality:-the resolution of image is defined as the number of lines per millimeter (lp/mm). The resolution of the DR using CCD is about 10 lp/mm as compared to the conventional x-ray which is about 12 to 20 lp/mm.

3- Sensor size: - some digital sensors are thicker and less flexible than intraoral film. Patient may complain of the bulky nature of the sensor and may be uncomfortable and may induce gag reflex.

4- Infection control: - some sensors can't withstand heat sterilization. Therefore the sensor requires complete coverage with plastic sleeves that must be changed with each patient to prevent cross contamination.

1.5.3. Focal trough

Dental panoramic radiography becomes a very popular radiographic technique in dentistry. In this radiograph the dental arch of the patient must be positioned in a narrow zone known as the focal trough (Whaite, 2007).

Goaz and White in 1994 defined the focal trough as a region in a space, located between the image receptor and the x-ray source which is the result from the synchronized movement and relative speed of the image receptor and the x-ray source to each other. On the other hand, White and Pharoah in 2000 defined the focal trough as a three dimensional curved zone or image layer in which the structures are reasonably well defined on panoramic radiographs. The image seen on panoramic radiograph consists largely of anatomic structures located within the focal trough. Objects outside the focal trough are blurred, magnified or reduced in size and sometimes are distorted to the extent of not being recognizable.

The size and the shape of the focal trough vary with the manufacture of the panoramic x-ray unit. In most panoramic x-ray machine, the focal trough is narrow in the anterior region and wide in the posterior region. Each manufacture provides specific instruction about patient positioning to ensure that the teeth positioned within the focal trough (Iannucci and Howerton, 2006).

Chapter two

Subjects, Materials and Methods

Subjects, Materials and Methods

2.1. Sample subjects:

2.1.1. Sample selection:

- A retrospective study consists of thirty (30) Iraqi subjects with age ranged from (18-35) years old attended at specialized private center for dentistry in Baghdad city, taking panoramic radiographs for different diagnostic purposes.

- The study was carried out from period between (January-March) 2018
- The study sample was divided into the following three groups according to the age:-

Group1 (18-23)
Group2 (24-29)
Group3 (30-35)

Also it was divided into two groups according to the gender.

2.1.2. Criteria for patient's inclusion: Involve:-

1. Patients who have acceptable mandibular occlusal plane were included to the study.
2. The panoramic radiographs should be without any gross anatomical abnormalities or pathologies that may obscure the examined area.

2.1.3. Criteria for patient's exclusion: Involve:-

1. OPG's that showed poor image quality.
2. OPG's with anatomical abnormalities or mandibular teeth were submerged or supra-erupted which affected mandibular occlusal plane were excluded from this study.

2.2. Case sheet

For the entire subject sample, the information was recorded on a case sheet as shown in Appendix1.

2.3. Materials:

2.3.1. X-Ray Machine:

The panoramic radiography machine which was used in this study is CS8100 Digital Panoramic and Cephalometric System manufactured by Care Stream Health, Inc.

The parameter settings were 80 kV, 8 mA, while the time of exposure was 10.78 seconds and the Magnification factor was 1.2 (± 10%). The radiographic image was viewed and manipulated on the computer monitor and then printed by hard copy printer.

Figure (2-1) Panoramic Radiography Machine (CS8100)

2.4. Methods

The panoramic radiograph for each subject was examined carefully (Right and left) sides & manipulated by the software system of the equipment to assess MF position by marking (the midpoint of the beginning of inferior alveolar canal) & then the (mandibular occlusal plane) was drawn passing through the cusp tip of the fully erupted 1st molar and should be parallel to the orbital floor, in order to obtain the following parameters:

1. The distance from the mandibular foramen to the anterior border of the ramus of the mandible in mm.
2. The distance from the mandibular foramen to the mandibular occlusal plane in mm.

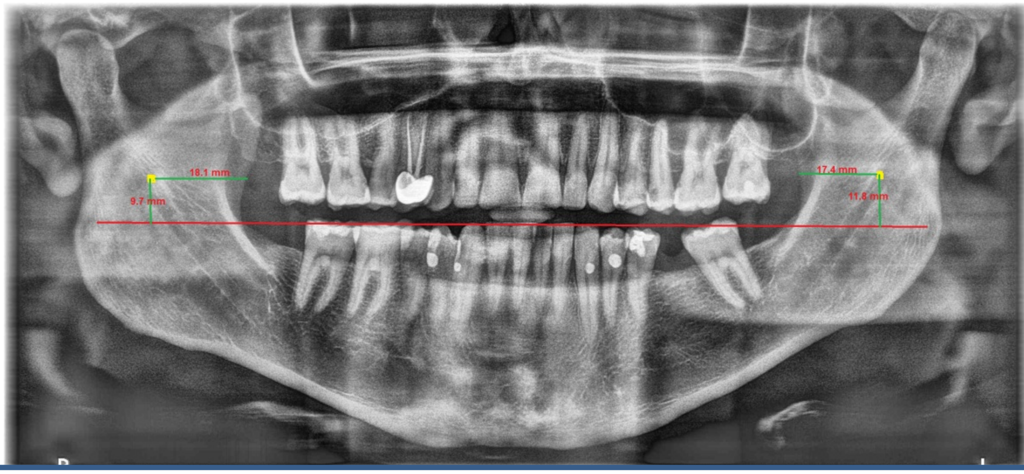


Figure (2-2): 32 years old male patient

Figure (2-3): 21 years old female patient

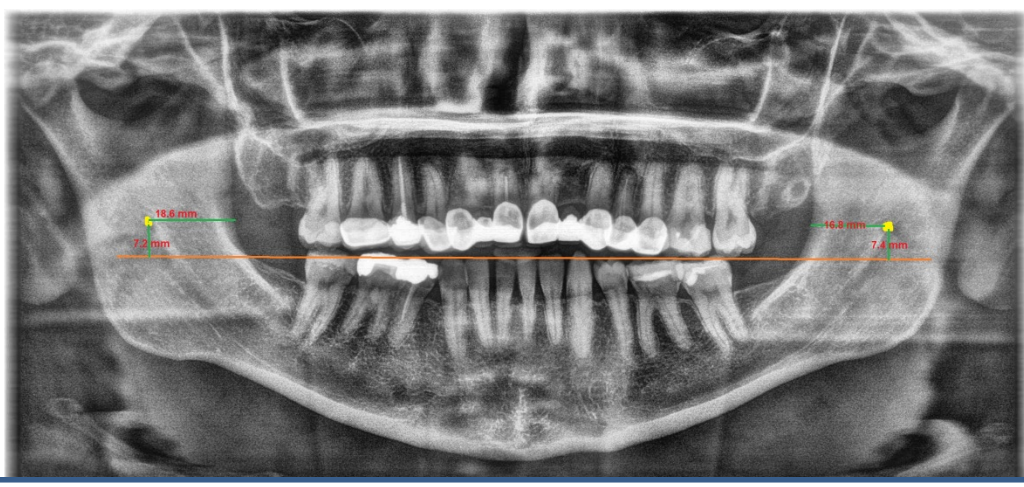


Figure (2-4): 34 years old male patient

Figure (2-5): 24 years old female patient

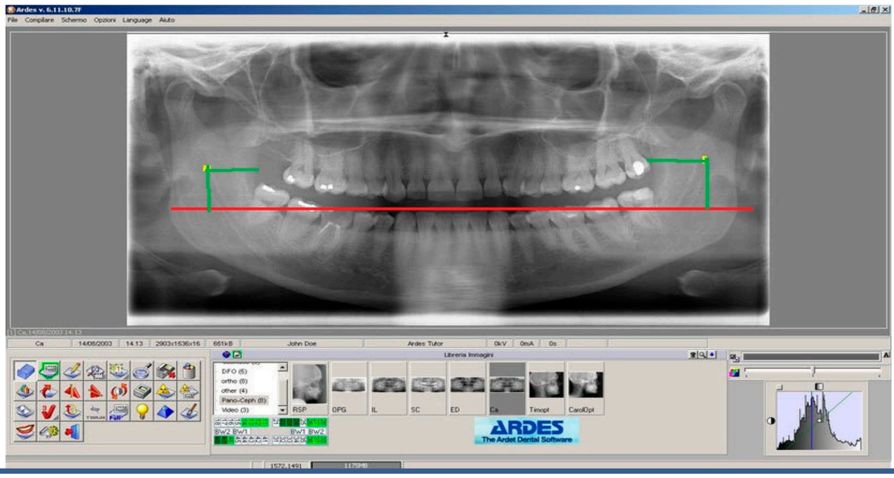


Figure (2-6): 30 years old male patient

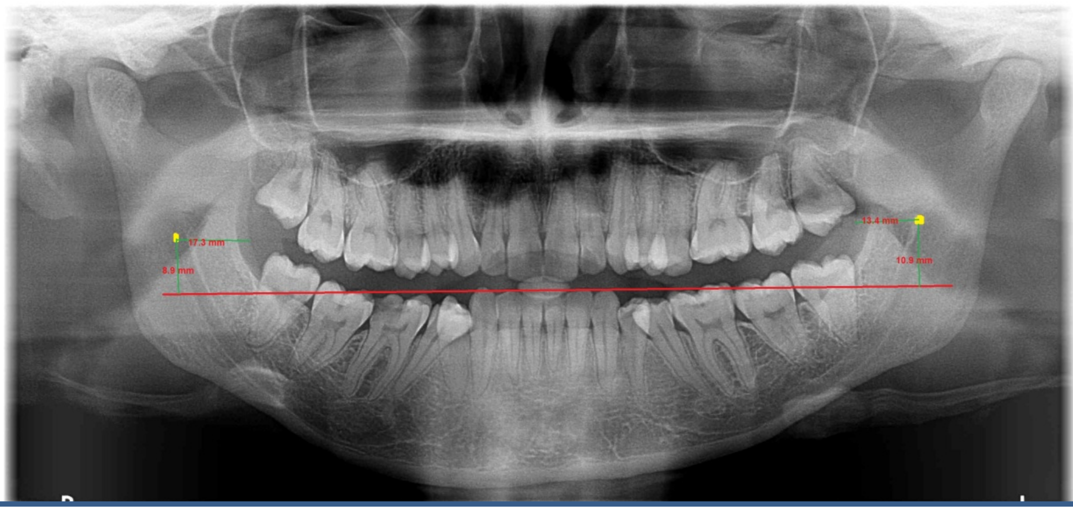


Figure (2-7): 29 years old male patient

Chapter three

Results

Results

3.1. Sample Description:

This survey was a retrospective study carried out on 30 Iraqi subjects between the age of 18 and 35 years old taking panoramic radiographs in Dr-Laith team center at Baghdad city.

These subjects were subdivided into groups according to the age, gender, and the side of the jaw.

3.2. Distribution of the study sample according to the gender:

The sample included 17 male (56.7%) and 13 female (43.3%) respectively as shown in table 3.1.

Table (3-1): Distribution of the study sample according to gender.

Gender	No. of individuals	Percentage
Male	17	56.7%
Female	13	43.3%
Total	30	100%

3.3. Distribution of the study sample according to the age:

The subjects were divided into three groups according to age. It was observed that 10 cases in the age group of 18-23 years (33.3%) , 9 cases in the age group of 24-29 (30%) and 11 cases in the age group of 30-35 years (36.7%) as shown in table 3.2.

Table (3-2): Distribution of the study sample according to the age.

Age Group	No. of subject	Percentage
G1(18-23)	10	33.3%
G2(24-29)	9	30%
G3(30-35)	11	36.7%
Total	30	100%

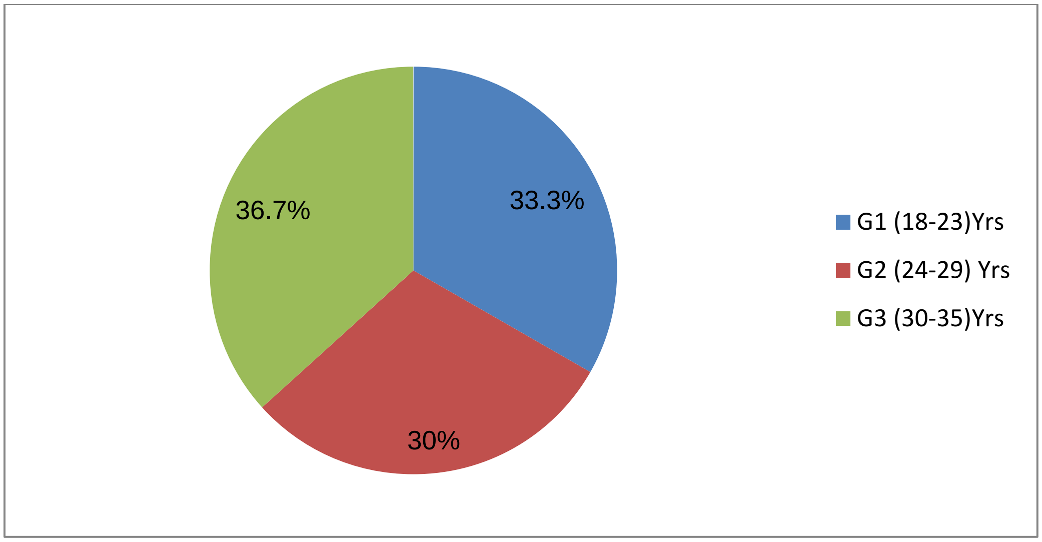


Figure (3-1) Distribution of study sample according to the age using Pie graph.

3.4. The linear measurements of MF position in the three study groups of the sample according to the side

In Group 1: It was found that the minimum distance from MF to AB of ramus in the right side was (13.6 mm) and the maximum distance was (21.1 mm) and the SD was (2.19) from the mean (15.97 mm), and the minimum distance from MF to the occlusal plane was (5.4 mm) and the maximum distance was (9.6 mm) and the SD was (1.51) from the mean (7.44 mm)

In Group 2: It was found that the minimum distance from MF to AB of ramus in the right side was (14.2 mm) and the maximum distance was (19.1 mm) and the SD was (1.67) from the mean (16.44 mm), and the minimum distance from MF to the occlusal plane was (4.9 mm) and the maximum distance was (11.8 mm) and the SD was (2.13) from the mean (8.35 mm)

In Group 3: It was found that the minimum distance from MF to AB of ramus in the right side was (14.9 mm) and the maximum distance was (19.6 mm) and the SD was (1.23) from the mean (17.5 mm), and the minimum distance from MF to the occlusal plane was (5.1 mm) and the maximum distance was (11 mm) and the SD was (1.8) from the mean (8.24 mm) as shown in table (3-3).

Table (3-3): Comparison of mean linear measurement (in mm.) of relative position of MF from the anterior border of the ramus & from occlusal plane on the right side between the three groups.

Study group		N	Mean	Min.	Max.	SD
G1	MF to AB of ramus	10	15.97	13.6	21.1	2.19
	MF to occlusal plane		7.44	5.4	9.6	1.51
G2	MF to AB of ramus	9	16.44	14.2	19.1	1.67
	MF to occlusal plane		8.35	4.9	11.8	2.13
G3	MF to AB of ramus	11	17.5	14.9	19.6	1.23
	MF to occlusal plane		8.24	5.1	11	1.80

In Group 1: It was found that the minimum distance from MF to AB of ramus in the left side was (12.8 mm) and the maximum distance was (17.1 mm) and the SD was (1.30) from the mean (14.57 mm), and the minimum distance from MF to the occlusal plane was (5.6 mm) and the maximum distance was (10.2 mm) and the SD was (1.52) from the mean (7.35 mm)

In Group 2: It was found that the minimum distance from MF to AB of ramus in the left side was (13.4 mm) and the maximum distance was (18.7 mm) and the SD was (1.71) from the mean (15.5 mm), and the minimum distance from MF to the occlusal plane was (5.4 mm) and the maximum distance was (11.3 mm) and the SD was (2.31) from the mean (8.8 mm)

In Group 3: It was found that the minimum distance from MF to AB of ramus in the left side was (12.6 mm) and the maximum distance was (18.5 mm) and the SD was (1.56) from the mean (17 mm), and the minimum distance from MF to the occlusal plane was (5.1 mm) and the maximum distance was (11.8 mm) and the SD was (2.17) from the mean (8.35 mm) as shown in table (3-4)

Table (3-4): Comparison of mean linear measurement (in mm.) of relative position of MF from the anterior border of the ramus & from occlusal plane on the left side between the three groups.

<table>
<tr><th colspan="2">Study group</th><th>N</th><th>Mean</th><th>Min.</th><th>Max.</th><th>SD</th></tr>
<tr><td rowspan="2">G1</td><td>MF to AB of ramus</td><td rowspan="2">10</td><td>14.57</td><td>12.8</td><td>17.1</td><td>1.30</td></tr>
<tr><td>MF to occlusal plane</td><td>7.35</td><td>5.6</td><td>10.2</td><td>1.52</td></tr>
<tr><td rowspan="2">G2</td><td>MF to AB of ramus</td><td rowspan="2">9</td><td>15.5</td><td>13.4</td><td>18.7</td><td>1.71</td></tr>
<tr><td>MF to occlusal plane</td><td>8.8</td><td>5.4</td><td>11.3</td><td>2.31</td></tr>
<tr><td rowspan="2">G3</td><td>MF to AB of ramus</td><td rowspan="2">11</td><td>17</td><td>12.6</td><td>18.5</td><td>1.56</td></tr>
<tr><td>MF to occlusal plane</td><td>8.35</td><td>5.1</td><td>11.8</td><td>2.17</td></tr>
</table>

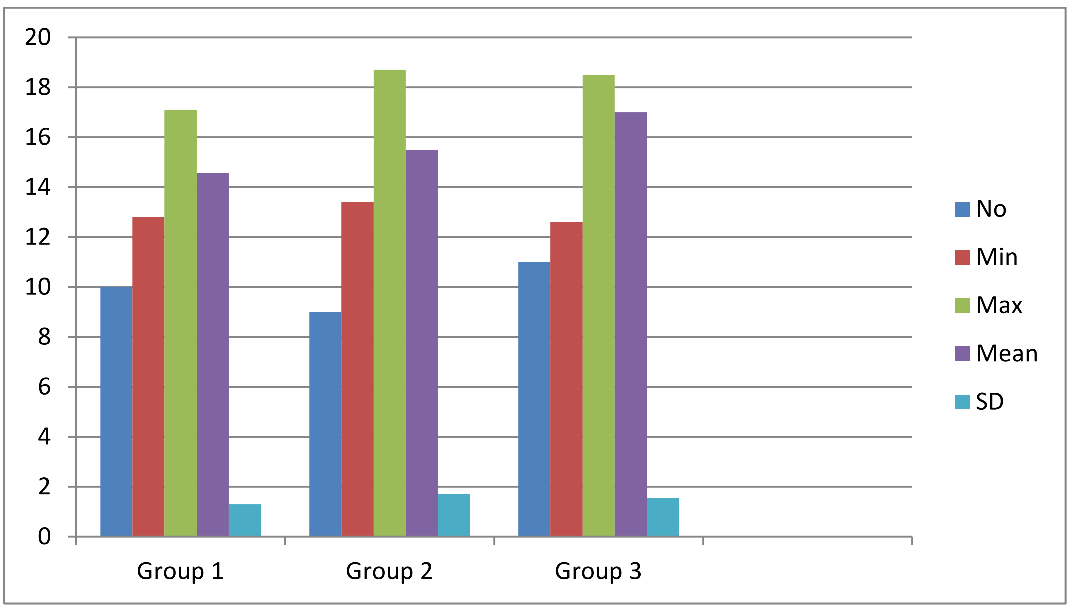


Figure (3-2): Comparison of mean linear measurement (in mm.) of relative position of MF from the anterior border of the ramus & from occlusal plane on the left side between the three groups using Histogram.

3.5. The relative position of MF on right & left sides in each study group

In Group 1 : It was found that the mean distance from MF to AB of ramus was (15.97 mm) and the SD was (2.19) for the right side and the mean distance was (14.57 mm) and the SD was (1.30) for the left side , and the mean distance from MF to OP was (7.44 mm) and the SD was (1.51) for the right side and the mean distance was (7.35 mm) and the SD was (1.52) for the left side as shown in table (3-5)

Table (3-5): Comparison of mean linear measurements (in mm.) between R&L sides in G1 for relative MF position to AB of ramus & occlusal plane.

position	sides	No.	Mean	SD
1.MF to AB of ramus	R	10	15.97	2.19
	L	10	14.57	1.30
2.MF to OP	R	10	7.44	1.51
	L	10	7.35	1.52

In Group 2 : It was found that the mean distance from MF to AB of ramus was (14.2 mm) and the SD was (1.67) for the right side and the mean distance was (15.5 mm) and the SD was (1.71) for the left side , and the mean distance from MF to OP was (4.9 mm) and the SD was (2.13) for the right side and the mean distance was (8.8 mm) and the SD was (2.31) for the left side as shown in table (3-6)

Table (3-6): Comparison of mean linear measurements (in mm.) between R&L sides in G2 for relative MF position to AB of ramus & occlusal plane.

position	sides	No.	Mean	SD
1.MF to AB of ramus	R	9	14.2	1.67
	L	9	15.5	1.71
2.MF to OP	R	9	4.9	2.13
	L	9	8.8	2.31

In Group 3 : It was found that the mean distance from MF to AB of ramus was (17.5 mm) and the SD was (1.23) for the right side and the mean distance was (17 mm) and the SD was (1.56) for the left side , and the mean distance from MF to OP was (8.24 mm) and the SD was (1.8) for the right side and the mean distance was (8.35 mm) and the SD was (2.17) for the left side as shown in table (3-7).

Table (3-7): Comparison of mean linear measurements (in mm.) between R&L sides in G3 for relative MF position to AB of ramus & occlusal plane.

position	sides	No.	Mean	SD
1.MF to AB ramus	R	11	17.5	1.23
	L	11	17	1.56
2.MF to OP	R	11	8.24	1.80
	L	11	8.35	2.17

Chapter four

Discussion

Discussion

A total of 30 subjects were included in this study. The maximum number of subjects was found to be in the age group of 30-35 years which is 11 subjects (36.7%). A retrospective study by conducted by Malka et al., in 2011 showed that the maximum number of subjects was in the age group 30-35 years, which is near the results of present study.

In the present study it was found that out of 30 subjects, 17 (56.7%) subjects were male, 13 subjects (43.3%) were female. Another study done by Osman et al., in 2015, it was found that out of 236 subjects, 134 subjects (58%) were male, while 102 subjects were female.

In the right side, the mean distance of MF from the AB of the ramus of the mandible in G1 was (15.97mm), while the mean distance from MF to the occlusal plane was (7.44 mm).

The mean distance of MF from the AB of the ramus of the mandible in G2 was (16.44mm), while the mean distance from MF to the occlusal plane was (8.35 mm).

The mean distance of MF from the AB of the ramus of the mandible in G3 was (17.5mm), the mean distance from MF to the occlusal plane was (8.24mm).

In another study done by Thangavelu et al., in 2018, it was found that the mean distance of MF to the AB of the ramus of the mandible was (18.9 mm), the mean distance from MF to the occlusal plane was (9.1mm).

In the left side, the mean distance of MF from the AB of the ramus of the mandible in G1 was (14.57 mm), while the mean distance from MF to the occlusal plane was (7.35 mm).

The mean distance of MF from the AB of the ramus of the mandible in G2 was (15.5 mm), while the mean distance from MF to the occlusal plane was (8.8 mm).

The mean distance of MF from the AB of the ramus of the mandible in G3 was (17 mm), while the mean distance from MF to the occlusal plane was (8.35mm).

In another study done by Renato et al., in 2014, it was found that the mean distance of MF to the AB of the ramus of the mandible was (15.3 mm), while the mean distance from MF to the occlusal plane was (9.1mm).

The variations that were found in this study as compared to other studies were due to the fact that the studied population in each investigation was quite different from each other in sample size, race & environment.

Chapter five

Conclusion

& Suggestion

5.1. Conclusion

1. From this study it can be concluded that the MF is approximately:

- (15.97) mm from the AB of the ramus of the mandible & (7.44) mm from the OP in the right side in the age group (18-23) years.
- (14.57) mm from the AB of the ramus of the mandible & (7.35) mm from the OP in the left side in the age group (18-23) years.
- (14.2) mm from the AB of the ramus of the mandible & (4.9) mm from the OP in the right side in the age group (24-29) years.
- (15.5) mm from the AB of the ramus of the mandible & (8.8) mm from the OP in the left side in the age group (24-29) years.
- (17.5) mm from the AB of the ramus of the mandible & (8.24) mm from the OP in the right side in the age group (30-35) years.
- (17.0) mm from the AB of the ramus of the mandible & (8.35) mm from the OP in the left side in the age group (30-35) years.

2. There was a gradual increase in MF mean distance from AB of ramus & above the occlusal plane in G1, G2, G3.
3. The MF position is not bilaterally symmetrical for any of the considered age groups.

5.2. Suggestions

- The use of cone beam computed tomography CBCT instead of Panoramic Radiography in study of MF position.
- The study of MF position in mixed dentition in children.
- The study of the relationship of MF position and the diseases affected the bone.
- The study of the effect of extraction of the posterior teeth on the MF position.

Appendix 1

Patient name :

Age :

Gender :

Address :

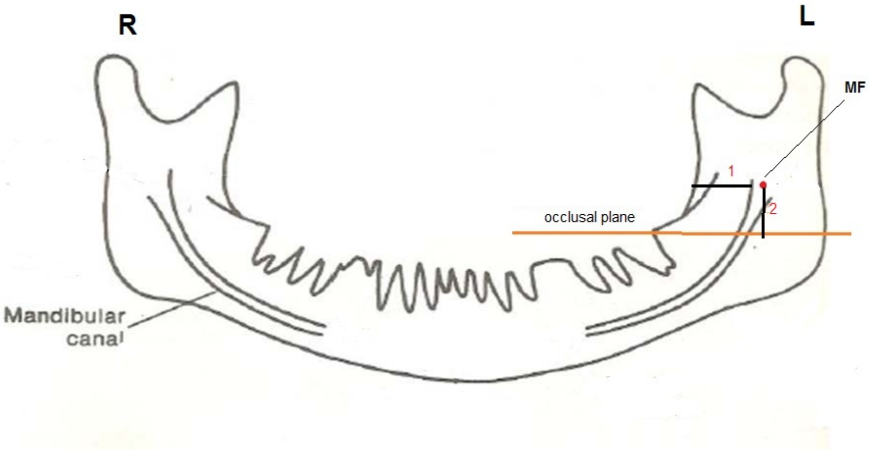
Occupation :

Panoramic report :

Position of Mandibular foramen	**Right side(mm)**	**Left side(mm)**
1.distance from MF-anterior border of ramus		
2.distance from MF-mandibular occlusal plane		

*occlusal plane should be parallel with the orbital floor

*linear measurements in (mm)



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