

BASIC RADIOLOGY

FOUNDATIONS AND PROFESSIONAL PRACTICE



Inyang Ukot

Bentham Books

Basic Radiology: Foundations and Professional Practice

Authored by

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ISBN (Online): 979-8-89881-201-0

ISBN (Print): 979-8-89881-202-7

ISBN (Paperback): 979-8-89881-203-4

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First published in 2026.

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FOREWORD

Dr Inyang Ukot is a graduate of the College of Medicine of the University of Lagos, Nigeria (1981). He also holds Fellowships in family medicine from the National Postgraduate Medical College of Nigeria (1991) and the West African College of Physicians (1995). He holds a Diploma in occupational medicine from the Royal College of Physicians of London (2005) #00005745. He was the coordinator of training in his faculty in the National Postgraduate Medical College of Nigeria between 1995 and 1999. He is an examiner in family medicine at both the West African College of Physicians (WACP) and the National Postgraduate Medical College of Nigeria (NPMCN).

Dr. Inyang Ukot is the best person to be the author of Basic Radiology: Foundations and Professional Practice for a couple of reasons:

- a) He has had a passion for details, communicating, and teaching spanning decades. He was involved in “teaching” right from his undergraduate days (as a college-employed student part-time demonstrator of Anatomy to junior fellow students in their pre-clinical years), 1979–1981.
- b) He commenced the writing of his first book in medicine the year after obtaining his first fellowship in family medicine, and many medical students have benefited from the MCQ book.
- c) He is still in the field of writing books, the latest books having a publishing date of 2023.
- d) Being a family physician, he has been privileged to have an extensive exposure to patients with most of the conditions in radiology.

He desires that physicians make right diagnoses promptly using a good grasp of fundamentals of Basic Radiology: Foundations and Professional Practice, commence prompt and accurate treatment, activate prompt referral of patients when required, to the specialists for appropriate high-level care, and that complications should be mitigated if they cannot be prevented.

Dr. Inyang Ukot writes medical books. His first book was published in 1996, and it was a Mobil Producing Nigeria Unlimited-sponsored MCQ book titled Medicine in the Frontline – 1000 MCQs and Answers (with Comments). This is the first textbook on Family Medicine emanating from the West African sub-region. He has more textbooks that simplify medicine ready for publication, and he desires and prays to stop writing on medicine within five years.

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PREFACE

Right from my first year in secondary school (or high school), I was interested in photography and promptly joined the photography club; I must confess that I almost “confiscated” the keys to the school’s dark room but kept it safely for other students who were interested in making use of the facilities there for development and printing of their photographic films. This was in the early 1970s in Nigeria, and the only photography experience was developing and printing in black and white.

For a medical student with an interest in photography, the interest shifted to Polaroid photographs that offered color photographs. In the latter half of the 1970s, the practice was to send Kodak or Agfa 24 or 36 roll color films to London for development and printing. Then came the long wait to receive by post both the finished product and the exposed film(s) in Lagos. It was only then that I could have the pleasure of experiencing the disappointment of seeing and scrutinizing the good or poor photographs, a representation of the good or poor quality of work I did in the first place.

It was in the clinical years in the medical school that I realized that I had not escaped black and white photography. Radiographs proved that. Radiology and the radiographs, part of medical imaging, have played a prominent role in the practice of medicine for doctors of first contact like me. Radiographs, which radiology offers doctors in various specialties, play an important role in most practices in low- and middle-income countries (including the least developed countries [LDCs]); this is despite advances in radio-diagnostics and medical imaging on the global scene.

Getting it right with radiographs is not the same as getting it right when looking at black and white or color photographs. Apart from the fact that the latter could be for fun, the former frequently has dire consequences when the person who “looks” at radiographs does not pay close attention to details or apply the fundamentals in determining the relevance of the findings. The physician must separate themselves from the ease and enjoyment of regular photographs when “examining” a radiograph for details to aid in arriving at a correct diagnosis. It is not always that scarce radiologists are available to provide us with a specialist’s opinion.

This book has a good mix of images obtained from the advanced medical imaging techniques in the appropriate numbers and Chapters. They make the book balanced as they keep doctors who practice in resource-poor countries abreast with these rapidly growing means of diagnosis and treatment, while concomitantly taking those who practice in advanced practice settings back to their roots to maintain currency rather than lose skills; this way, everyone maintains a balance. My conviction in proceeding to actualize this dream is that if some medical students and doctors are like me, this small book may be of some value to them and to their patients.

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DEDICATION

This book is dedicated to SHARON OBANDE a promising and talented teenager who departed this realm too early for any to have anticipated.

It is also dedicated to my late parents HRM Owong (Barrister) Akpanika M. Ukot, First Paramount Ruler of Ibeno Local Government Area, Akwa Ibom State, Nigeria and Akwaha Obonganwa Grace Akpanika Ukot.

ACKNOWLEDGMENTS

My appreciation goes to Dr. Kaalu William MBBS, FWACS (Consultant Radiologist) who went through the stress of meeting the requirement of providing, at short notice, images of ultrasonography, mammography, computed tomography (CT) scanning, and magnetic resonance imaging (MRI) as originals that I used to create the following Figures: **Chapter 2** Figure 3 and Figures 6 to 17. **Chapter 8** Figure 26; **Chapter 9** Figure 23, Figure 24, and Figure 25. In **Chapter 10**, Figures 3 to 9 and Figures 11, 12, and 13, while for **Chapter 11**, Figures 9 to 13.

I acknowledge Professor Sunday B. Udoh, Professor of Family Medicine at the University of Uyo, Uyo, Nigeria, for providing me with ultrasonographic images on various topics as shown in the following Figures: **Chapter 6**: Figure 13 and Figure 14; **Chapter 8**: Figure 25; **Chapter 9**: Figures 12 to 22.

Dr. Mayen Egbe, M.B.; B.S., FRCP (UK), MSc., MMed., PGDip. provided all the ECG images in **Chapter 2**. They are picked, with permission, from Essentials for Practice of Medicine in the Frontline, Volume 2, by Dr. Inyang Ukot.

More recently, there has been the great input towards top-level radiology and other imaging studies that the following doctors provided for patients in their highly esteemed hospital group. These doctors include Dr. Mohammed Zango, Dr. Musa Shaibu, Dr. Bunmi Oyetunde, Dr. Edwin Bako, and Dr. Peter Nmadu. They kept a highly motivated team not only in medical imaging but also in laboratory and other services, which provided excellent services to full-time and part-time doctors, and I belonged to the latter category, briefly. In radiology, Messrs. Thank God and Echegi have been very helpful to us, the external consultants who rendered locum services.

Going down memory lane, I acknowledge the following doctors who either headed hospitals where I worked or were at the top of the teams that provided guidance and training to me during my medical practice journey. They include Prof. Emmanuel Ekanem, Dr. B. Koleowo, Dr. Dotun Lamikanra, Prof. Asuquo D. Ekanem, Prof. J. J. Andy, Prof. Akpan Otu, Prof. Emmanuel Ezedinachi, Dr. Victor Onoyom-Ita, Dr. Tunde Soley, and Dr. Funmi Soley.

Further back is this set of doctors who provided me with the much-needed opportunity to build on the solid foundation I had obtained in medical practice. I had exposure to them within the first five and ten years of practice as a doctor – which coincided with my postgraduate training (residency). The first is Prof. Edward B. Attah who, in October 1985, made it possible for me to start residency in family medicine as the first Assistant Lecturer in General Medical Practice (now Family Medicine) in the University of Calabar – and thus the first in Nigeria as this medical school is the first to establish and run an undergraduate program for Family Medicine in Nigeria. The next is Dr. Eson Ejemot Ecoma who was a perfect combination of a head of department and a mentor during my residency years and, upon his retirement his successor, Dr. E. Udoh, played his own role that was majorly saddling me with delivering the early morning lectures on topics in General Medical Practice (now Family Medicine) to clinical-year medical students. The examinations were taken in conjunc-

tion with Community Health at the time before the split to establish Family Medicine as a Faculty in the University's medical school and a department in the Teaching Hospital.

The University of Calabar Teaching Hospital (UCTH) did not have accreditation for the final stage of residency in my specialty, and so I had to take leave from the Teaching Hospital (as I had by then opted to exit the services of the University of Calabar to concentrate on residency). Where I opted for was NKST Hospital, Mkar, near Gboko, in Benue State; in this mission hospital, the medical superintendent, Dr. Samuel Tor-Agbidye, held sway clinically and administratively. One unforgettable and unique practice was morning clinical meetings that the medical superintendent held with medical officers and those of us who were residents. During these morning meetings, we honed the craft of critically examining radiographs with critique and contributions from colleagues and with guidance from the medical superintendent. In this large and busy accredited postgraduate training center located in a peripheral area, the experience was invaluable and contributed significantly to my having the boldness to attempt (as a non-radiologist) the writing and eventual actualization of this book. Later, the retired Dr. Eson E. Ecoma became the Chair of the Board of the University of Port Harcourt Teaching Hospital, Nigeria, where I became the first and, at 34, the youngest head of the general outpatients department (GOPD) in 1991.

Before residency, and immediately after going through the one-year mandatory national service overseen by the National Youth Service Corps (NYSC) and designed for Nigerian citizens who are graduates from tertiary educational institutions, I worked in the private sector under Dr. Simon N. Okpokam, a remarkably diligent and reputable gynecologist. Dr. Simon Okpokam exposed me to principled private medical practice in his busy Atan Specialist Clinic, Calabar, Nigeria. The medical imaging during this period (1983 to 1985) was radiography, and this was part of buttressing a sound early clinical exposure for me.

The most crucial foundation I had was during my internship year in Eku Baptist Hospital, Eku, Delta State, Nigeria. This was a reputable and highly functional medical facility established by the Baptist Church and run by Baptist Church missionaries. The experiences in this hospital have remained memorable forty-three years on (since 1981) because of Dr. J. C. Abel (American surgeon), Dr. Darrell Osborne (Canadian gynecologist), Dr. Martha Hagood (American gynecologist), Dr. George (Indian pediatrician), and Dr. Jedidiah Agbowu (Nigerian physician).

I feel indebted to the above dedicated doctors and cannot help but do the unusual (providing this detailed chronological set of acknowledgments).

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INTRODUCTION

Basic Radiology: Foundations and Professional Practice commences with two introductory Chapters *viz.*: Chapter 1: Introduction to Radiology; Chapter 2: Specialized Imaging Techniques, and ends with a self-assessment provided by Chapter 12 with fifty single best answer (SBA) multiple-choice questions (MCQs) which come with Answers and robust Notes. Each MCQ provides the reader with four options to pick the best among them as the Answer. In-between these three Chapters are nine Chapters that are mainly divided according to systems of the human body as follows: Chapter 3: Respiratory System, Chapter 4: The Skeletal System: Axial Skeleton, Chapter 5: The Skeletal System: Appendicular Skeleton, Chapter 6: Urinary System, Chapter 7: Cardiovascular System, Chapter 8: Gastrointestinal System, Chapter 9: Reproductive System, Chapter 10: Nervous System, and Chapter 11: Hematopoietic, Endocrine, and Miscellaneous Diseases.

This book covers radiography, mammography, ultrasonography, computed tomography (CT) scanning, and magnetic resonance imaging (MRI). There is a good mix of images obtained from these imaging modalities, and the author inserted them deliberately and avoided unnecessary duplication of cases used in the Figures. The emphasis of this book is not so much on the purely academic and technical aspects but on the utilitarian value of the contents; the areas covered are treated and presented from the angle of their place in a physician's professional practice. The topics, therefore, briefly address as many common conditions as are deemed essential in various body organs that constitute the systems.

A doctor need not be a radiologist to make use of the information that is obtainable from radiographs (X-ray images), mammograms, ultrasound scans, CT scans, and images from magnetic resonance imaging (MRI). This book's Chapters show the reader for what diagnostic use or value in clinical care each of the imaging modalities should be requested. Considering their relatively high cost, especially in low- and medium-income countries (LMICs) and the least developed countries (LDCs), a physician must know which medical imaging investigation the best option is to ensure that the index patient and their family are not unduly burdened financially if they are private, fee-paying patients; this is the case in some of these countries with low uptake of health insurance coverage, if available. Cost considerations should, however, not be the primary determinant for making use of the best available medical imaging services; otherwise, the clinician may breach some ethical principles.

This book provides medical students and doctors, in most circumstances and levels of clinical practice, with an understanding of the principles for efficient medical service delivery. The images are highly illustrated both anatomically and clinically.

CHAPTER 1

Introduction to Radiology Foundations

Abstract: Without the need for a search for pathology in the human body, there would be no necessity for investigations. Investigations really commence when a doctor or a medical student listens to and asks their patients questions. Thereafter, they examine the patients and determine the appropriate investigations by “external” professionals. Though medical care is a team effort, this author sees investigations as “third party” in the sense that they are outside the immediate relationship between the patient and the physician. These investigations may involve pathologists (and they are various) or medical imaging professionals (there are a myriad of them too). In this book, reference is given to the specialty of radiology and the medical imaging specialists.

Keywords: Computed tomography scan, CT scan, Magnetic resonance imaging, MRI, Radiography, Radiographs, Radiology, Ultrasonography, Ultrasound, X-rays.

INTRODUCTION

The history of radiology is inextricably tied to Wilhelm Roentgen, who discovered X-rays in 1895 [1]. The initial and subsequent years were years of gaining further understanding of the utility of this investigation modality and the dangers associated with its use; these led to progressive positive changes that made radiography safer. It took an additional seventy-five years for computed tomography (CT) scanning to be introduced. This write-up is not about this and the latter means of medical imaging, but only about radiography and radiographs. Radiographic images have metamorphosed from images in physical form to electronic images that are transmitted online and are shareable in real-time when required. The equipment is more robust, more precise, and more user-friendly, and patient-friendly, and produces images virtually effortlessly.

Digital radiography involves a direct screen display of the radiographic image generated by the machine’s image detector and sent to the screen. Digital radiography may be direct or indirect [2]. Computed radiography requires the use of cassettes, but direct and indirect digital radiography do not require cassettes [2].

The summary is that while the original analog radiographs (in conventional radiography) required chemical processing and physical X-ray films, in digital radiography, a radiation source creates an image, and a sensor captures the image, which specialized software converts into a two-dimensional image that is not only displayed but may also be adjusted by enhancement [3]. The images are stored on a server, and any patient's information can be accessed when the patient is available for consultation, in the emergency room, operation room, or wards; the radiographic images can be recalled anytime the patient returns for a follow-up consultation and may be shared with colleagues and used for teaching [3].



Fig. (1). An X-ray machine and the patient's cubicle.

Radiographic Images

X-ray images are very important in helping the medical student or doctor to make or confirm a diagnosis. Starting with radiographic images, for radiological investigations to be useful, they must be relevant, timely, and the views ordered must be correct. Radiological and, indeed, other diagnostic aids should not be ordered "routinely," and neither should they take the place of the clinical acumen of the doctor. It is not every case of the abdominal or chest problem that requires investigation with X-rays. It remains a part of the training of a medical student in

the clinical years and practice for every doctor to take a good history, examine the patient, and attempt to come to a diagnosis. If case of a medical student, it is necessary to develop an interest in and a habit of participating in requesting investigations (including radiological) that would assist in confirming or ruling out the tentative diagnosis under the guidance of the consultant. Whether a medical student or a practicing doctor, the history and clinical examination may, for example, point towards a fracture, congestive cardiac failure, spondylosis, or other forms of arthritis – in such cases, requesting X-ray images is justified, and the request should be made.

The quality of the radiographic image should be good if the machines are modern and well-maintained, but this is not always the case in resource-poor settings. The images in this section are generally of good quality, and they should help a medical student or an inexperienced physician grasp the features that enable one to make a diagnosis with relative ease.

Fig. (1) shows the machine and cubicle while Fig. (2) shows the radiography machine with its table. The patient is on the table preparatory to the radiographer carrying out the final part of the investigation procedure. Following the patient's complaint of a month-long unrelenting right-sided lower backache extending to the right loin with the pain getting aggravated by sitting and relieved by standing, the doctor requested lumbo-sacral radiographs (antero-posterior and lateral views) for this patient, apart from an abdomino-pelvic ultrasound scan, which showed no renal abnormality. The procedure consisted of the following:

- The radiographer received the request form from the requesting physician and confirmed the investigation to be carried out.
- The receptionist directed the index patient to the X-ray room.
- The radiographer confirmed the identity of the patient and welcomed the patient to the room.
- The radiographer directed the patient to the changing cubicle within the X-ray room with instructions on what the patient should do.
- The patient removed all clothes, shoes, wrist watch, and dropped the phones and metallic objects like cuff links and belt that had a metallic portion, and kept them in the cubicle, then donned the open-back gown/cloth apron.
- The radiographer assisted the patient to sit on the equipment's table, lie down supine, and shift the body as directed.
- The radiographer also adjusted the overhead piece of equipment to achieve a desired view of the lumbo-sacral area.
- The radiographer returned to the adjoining room that houses the controls, permits satisfactory vision of the patient on the table, and took the X-ray –

Specialized Imaging Techniques (An Introduction)

Abstract: Specialized medical imaging techniques have been developed over the years. There is a plethora of them, and more are under development. Specialized medical imaging techniques have added flair to the specialty of radiology, just as it has increased its scope. Not only the possibilities of utility have been increased, but exactitude has also been significantly improved. Gone are the days when “exploratory laparotomy” held sway (especially in developing countries), for pre-operatively, a surgeon had a clear idea of what to encounter in any part of the body. This provides more assurance, a good idea of what type of anesthesia and experience of the anesthetist is required, how long the surgical intervention would last, and essential additional support ab initio. These modalities have come to stay and will only get better. It is important for medical students to have a good idea of them and for every doctor to know their value and for what they should be requested singly, serially, or in combination.

Keywords: CT scanning, Electrocardiography, ECG, EKG, MRI, Ultrasonography.

INTRODUCTION

For the purpose of this book, the only medical imaging technique that is not included in advanced imaging techniques is conventional radiography that uses physical radiographs; this means that this Chapter covers digital radiography. Other aspects that this Chapter covers include electrocardiography (ECG, EKG), ultrasonography, computed tomography (CT) scanning, and magnetic resonance imaging.

Each of the imaging techniques described in this chapter is discussed under the following subheadings:

- Principle
- Purpose
- Equipment
- Product

Electrocardiography

Principle

Cardiac muscle fibers generate electrical potentials as they go through every cardiac cycle. What the electrocardiograph machine does is detect these electrical potentials of low amplitude on the surface of the human body. To achieve this, the equipment is attached to its electrodes, which are connected to the person's body—precisely on the lower limbs and specific sites on the anterior chest wall. When the machine picks up these potentials, it amplifies them and follows up by displaying the record on a specially designed graph paper or on display monitors mentioned below for continuous monitoring of the patient [1].

The principle can be summarized as the identification of normal and abnormal electrical activity of the heart and presenting it graphically for a physician or other healthcare workers to interpret and use the findings to care for the patient or escalate for specialist intervention.

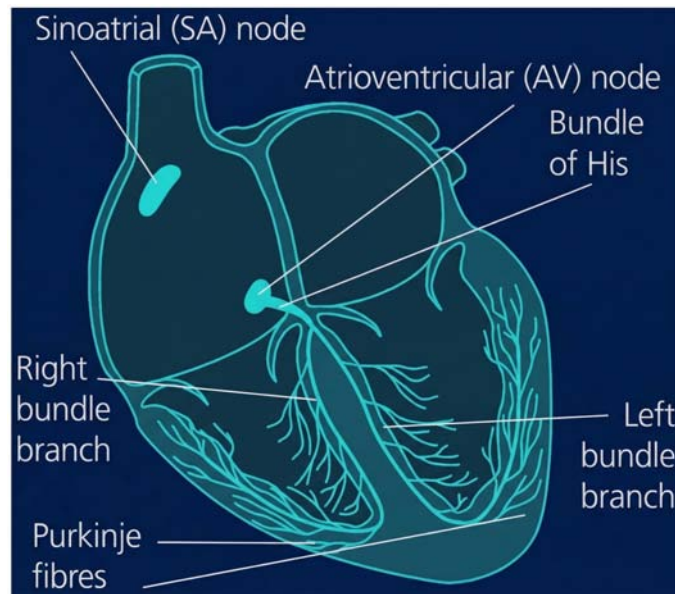


Fig. (1). The electrical conducting system of the heart.

Purpose

The electrocardiogram (ECG) is the most valuable test available to physicians and other healthcare personnel for the purpose of analyzing and interpreting the rhythm of the heart, abnormalities in the heart's conduction system, and recognizing myocardial ischemia [2].

The additional usefulness of ECG is for assessing abnormalities of the heart in patients with conditions such as hypertensive heart disease, cardiomyopathy, valvular heart disease, and pericarditis [2].

To achieve this purpose, the patient or the subject for electrocardiography must be linked to the equipment as diagrammatically represented below:

While Fig. (1) represents the electrical conducting system of the heart, Fig. (2) demonstrates ECG lead placement on the chest wall. Note: RL and RL refer to the right leg and left leg, which are not shown in the image, respectively.

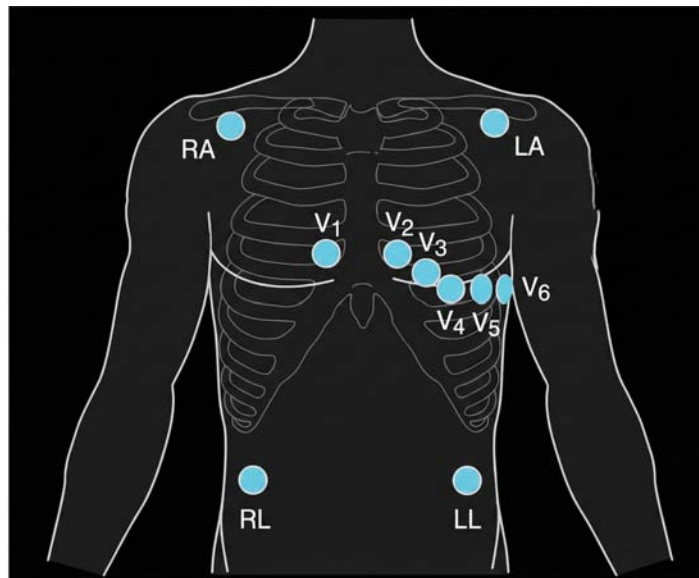


Fig. (2). ECG lead placement on the chest wall.

In standard medical practice settings, ECG monitoring is done continuously on certain patients in the emergency room, intensive care unit, or the general ward; the idea is to have a clear picture of disease progression or disease resolution [2].

These ECG records can be stored electronically for retrieval when required for review of the patient's condition or for research purposes [1].

Equipment

The electrocardiography machine has the electrodes and their cables linked to the machine and kept ready for use.

The electrodes are propped up so that they are safely kept while they are not in use.

The Respiratory System

Abstract: Chapter 3 marks the start of the subsequent chapters that organize medical imaging according to the body's systems. The author chose to start the book with the respiratory system, structurally focused on the chest and is the part of the body that tends to receive the highest number of requests for the most basic medical imaging modality – radiography. Chest radiographs are still available and valuable globally. Chest X-rays [1] are of greater significance in resource-poor countries; this is because the equipment to perform chest radiography is near ubiquitous in the distribution of these places.

Keywords: Chest X-ray, POPIRAM.

INTRODUCTION

This chapter contains normal chest radiographs and the ones that demonstrate deviation from the normal. The normal chest radiograph is the very first radiograph in this book. This author gives it this “pride of place” because it deserves it. The gross anatomical features of a normal chest X-ray are presented. The author expects the reader to become conversant with the abridged information that this Chapter provides on this radiograph. A general practitioner or specialist will deal with patients who require a request for this type of radiograph. It is important to get the anatomy right and to use it to categorically determine that the result is a normal chest radiograph. Here in, the focus is on plain chest radiography. Which other radiological investigation does a physician request for a person who appears normal and comes for a pre-school medical evaluation, immigration assessment, or pre-employment medical examination? Chest X-ray is one of the most requested radiological investigations in developing countries [1]. Chest radiography is done for patients who are suspected to have disease conditions that arise from the chest (like tuberculosis and pulmonary embolism [respiratory] or like pericardial effusion [cardiac]) just as it is requested in patients whose health challenges are totally outside the chest (*e.g.*, patients suspected of having metastatic deposits from carcinomas that involve the lungs and bones of the chest *via* hematogenous spread) [2, 3]. One of the illustrations in the article by Gronner and Ominsky showed a brassiere. The “transvestite’s” water- and gas-

filled brassiere gave the semblance of pulmonary cavitations or loculated hydropneumothoraces. The image demonstrated metallic brassiere hooks [4].

At other times, a chest radiograph may be required to confirm the position of iatrogenic intrathoracic objects like endotracheal and similar tubes that are used for the treatment of patients [1].

The Chapter also presents a few examples with abnormalities, and these include conditions like pneumonia, bronchopneumonia, pulmonary tuberculosis, and pleural effusion.

The author has crafted illustrations of abnormal radiological signs that are useful to non-specialists; where the background of a normal chest radiograph is used.

Normal Chest Radiograph

The normal chest consists of bony, cartilaginous, muscular, and air-filled organs/tissues. The air-filled structures (trachea and bronchi) appear “black,” the lungs that consist of numerous alveoli that are individually air-filled appear “dark,” muscular organs (heart and diaphragm) appear less dark, while bones (like ribs and clavicles) appear light in color. It must be noted that none of the usual structures in the thorax is “white” or “black.” Only objects that are not supposed to be in the chest, *e.g.*, metals and metallic objects, are white; and in pneumothorax, where the normal potential space (pleura) has become filled with air and appears black.

When reading or studying a chest radiograph, experts recommend that no part of the X-ray film should be left unattended. They have crafted some mnemonics that assist in ensuring a step-by-step approach to executing this task. The one that this author adopts for this Chapter is POPIRAM [5]. ABC-to-I is a suitable alternative.

P = Projection of the X-ray, *i.e.*, taken from the back to the front (Posterior-anterior), from the front to the back (Antero-posterior), or sideways (Right lateral or left lateral).

O = Orientation. If there is a physical film, ensure that you place the radiograph the right way, *i.e.*, (L) for left and (R) for right. If electronic, identify or confirm the sides before reading the chest radiograph. The marker should be used as a guide, but should not be followed if it is obviously wrong compared with clinical findings from the index patient or normal anatomical relationships.

P = Penetration. Is it of normal penetration, with the various densities adequately represented? When there is over-penetration, the lungs look black, and when it is a case of under-penetration, they could look like bone.

I = Inspiration. When there is normal inspiration, the shape of the heart is normal and the domes are shown but when there is expiration or inadequate inspiration, the heart looks “compressed” superior-inferiorly.

R = Rotation. Is there rotation to one side or the other? Equality or otherwise of the distances between the vertebral spinous processes and the medial (sternal) ends of the clavicles enables assessment of this feature.

A = Angulation may be present or absent.

M = Motion. The presence or otherwise of motion when the radiograph was taken can be determined as movement by the patient causes a blurring of the radiographic image.

The next useful mnemonic uses the letters A to I, thus:

A = Airway. Pay attention to the centrality, or otherwise, of the trachea; it could deviate to the right or to the left. The normal is the central trachea. Follow the trachea until you get to the carina, where there is a bifurcation of the trachea into the right and left main bronchi. Depending on the quality of the chest radiograph, you may be able to follow further branching of the bronchi.

B = Bones. Identify and examine the bones, viz.: clavicles, scapulae, ribs, and occasionally parts of the shoulders. Though you may be able to view the lower cervical vertebrae and the thoracic spine, the radiographic view is not for detailed examination of these vertebrae.

C = Cardiac. Going clockwise, the heart shadow shows the right border made up of the right atrium, the superior vena cava (and the right main bronchus), the top of the image consisting of the aortic arch, the left border consisting of the pulmonary trunk, the left atrium, and the left ventricle ending with its apex. The position of the right ventricle is in-between the right atrium and the left ventricle.

D = Diaphragm. The diaphragm has two domes, the right of which is usually slightly higher in level than the left. The angle between the inner chest wall and the diaphragmatic dome (the costophrenic angle) and the angle between the heart and the diaphragmatic dome (cardio-phrenic angle) on both sides should be examined for normality or otherwise. The cardio-thoracic ratio should also be measured, the normal ratio being not more than 0.5.

E = Effusions and extra-thoracic soft tissue. There should be no effusions in the pleura or pericardium. Extra-thoracic soft tissue may be normal or abnormal. The breast is a normal extra-thoracic soft tissue found in adult females. The thickness between the thoracic cage and the skin has a bearing on the state of nutrition of

The Skeletal System: The Axial Skeleton

Abstract: The axial skeleton is a part of the skeletal system. This component of the human body provides a function that is equivalent to the stem of a tree. Everything tends to revolve around the axial skeleton. It harbors the brain, the spinal cord, and nerve “exits,” just as its rib cage provides accommodation for the heart and lungs. With the combination of flexibility and rigidity, the cartilages and hyoid bone provide stability to the trachea and larynx and avoid the collapse of this “gateway” to the rest of the respiratory system. The bony aspect of the axial skeleton is made up of eighty bones; these bones include the tiny ossicles (malleus, incus, and stapes bilaterally)[1].

A good understanding of the bones, cartilages, and ligaments of the axial skeleton is important for every medical student and practicing doctor. All forms of medical imaging for diagnostic and therapeutic purposes are applicable to the axial skeleton. It deservedly takes Chapter 4 of this book.

Keywords: Cervical spine, Clavicles, Lumbar spine, Ribs, Skull, Sacrum, Sternum, Thoracic spine.

INTRODUCTION

This chapter covers images of the skull (excluding the paranasal sinuses that are covered under the last chapter of miscellaneous diseases), cervical spine, thoracic spine, lumbar spine, and sacrum. Each shows the normal before the abnormal. Being the “stem” of the human body, diseases that affect the axial skeleton have a significant negative and sometimes, debilitating effect on patients. It is important for the first doctor who provides care for a patient with departures from the normal in this part of the skeletal system to pay close attention to the patient’s history, examine them systematically and logically, and request for medical imaging that is relevant to making a definitive diagnosis and determining the mode of treatment.

The axial skeleton incorporates the ribs, clavicles, and sternum and their cartilages and consequently contributes significantly to human flexibility in movement and support to the entire frame and attachments (muscles, *etc.*) [2]. This chapter is not on the musculoskeletal system, and so the muscles in all these parts of the body that relate to the axial skeleton are not discussed. It is obvious that the “vital

organs” are enclosed in the axial skeleton. It is, therefore, essential for every medical student and doctor who finds evidence of bridging the integrity of the axial skeleton to act promptly to avoid temporary or permanent disability, if not death.

The Normal Skull

Embryologically, the coronal suture is a derivative of the paraxial mesoderm. The microvasculature of surrounding tissues provides the coronal suture with nutrients, as its nature, dense fibrous tissue, does not allow it adequate vascularization. The coronal suture shields the middle meningeal artery, an important artery in the brain [3].

The sagittal suture is a serrated synarthrosis in the midline of the skull and forms the link between two parietal bones [4]. This suture is deemed to have branched bilaterally to create the coronal sutures and thus allow a more equitable distribution of forces against the human skull vault [5].

The lambdoid suture (also referred to as the lambdoidal suture) is a posterior suture. On each side, it runs from the asterion. The asterion is where three suture lines of skull bones meet. The asterion is formed by the occipital bone posteriorly, the parietal and temporal bones. The site is where the lambdoid, occipitomastoid, and parieto-mastoid sutures meet.

The lambdoid suture links the posterior ends of the parietal bones with the occipital bone. The Greek uppercase letter lambda (Λ) is what gave this suture its name, for it closely resembles that letter [6]. This suture is divided into three parts, *viz.*: pars lambdica, pars intermedia, and pars asterica [7].

Studies on cadavers, unidentified individuals, and those who have become skeletonized have shown that cranial suture closure is a useful tool associated with how old the person is. It is therefore useful in determining the age of the person at the time of death and provides information of forensic pathology significance. The lambdoid suture plays an important role in these studies as it is the last of the cranial sutures to close [7].

The mandible (the lower jawbone), the only major bone in the skull that is moveable, bears human lower dentition, works in opposition against the upper teeth-bearing maxilla during biting and mastication, and is attached to the rest of the skull by muscles, cartilages, including to the temporal bone at the temporomandibular joint [8]. The mandible is the largest skull bone in the face of a human. The muscles of facial expression have their insertions into the mandible. The mandible is therefore essential for human feeding and for the expression of

feelings using the face [9].

Figs. (1 and 2) are anteroposterior and lateral view radiographs of the skull of a young adult male aged 24 years. The cranial vault, sutures, and Sella turcica are within normal limits. The radiographs show a normal skull.

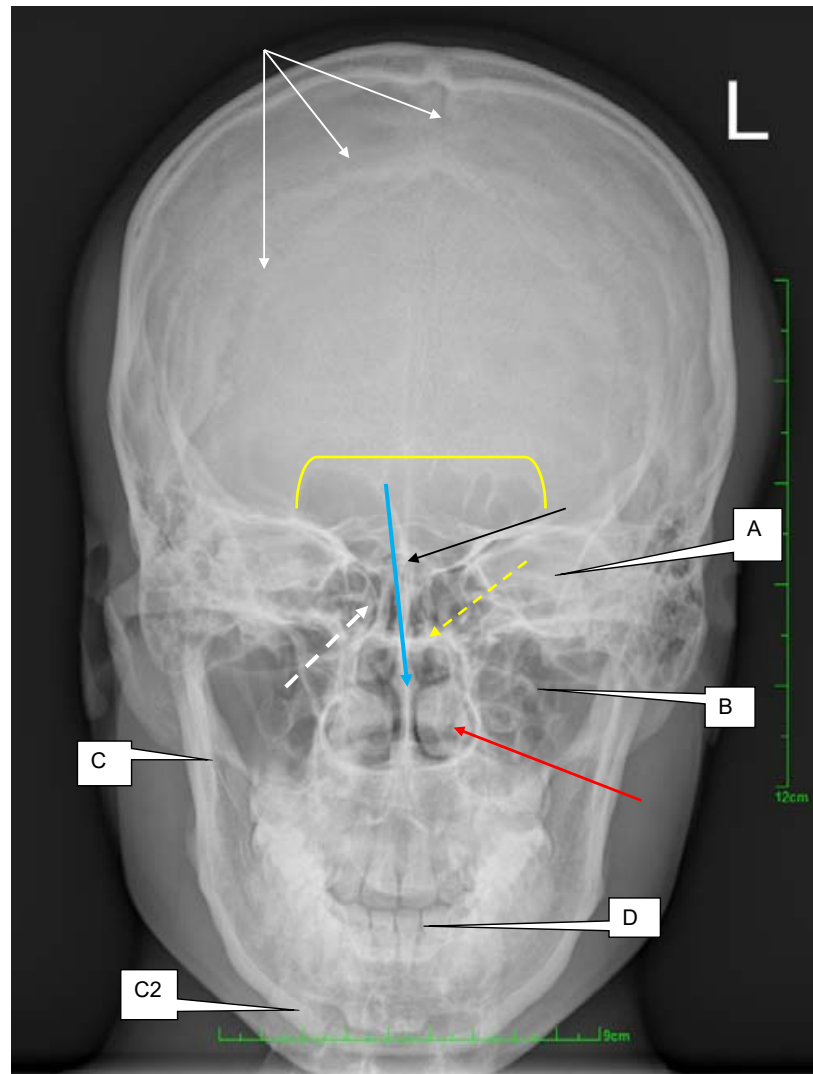


Fig. (1). White arrows = From top: sagittal suture, coronal suture, lambdoid suture; Yellow bracket = Frontal air sinuses; Black arrow = Crista galli; Broken yellow arrow = Cribriform plate of the ethmoid bone; Broken white arrow = Right ethmoidal air sinus; Blue arrow = Nasal septum; Red arrow = Inferior nasal concha; A = Orbit; B =Maxillary sinus; C1 = Ramus of mandible; C2 = Body of mandible; D = Teeth.

The Skeletal System: The Appendicular Skeleton

Abstract: To this author, the skeletal system deserves to be discussed in two chapters. It provides a balance in the relative length of the chapters. Appendicular skeleton encompasses the “appendages” of the skeletal system, but they are not appendages in the meaning ascribed to the human appendix. The appendicular skeleton is more or less the “branches” of a tree. Since the stem and roots are important, they cannot fulfill their overall purpose without these branches. The appendicular system receives its empowerment from the axial skeleton and cannot survive without it; the axial skeleton is potent only to a certain level without the appendicular system. This component is described in this chapter.

Keywords: Calcaneus, Fracture of femur, Greenstick fracture, Humerus, Hip joint, Knee, Lower limbs, Osteoarthritis, Phalanges, Radius, Shoulder joint, Shoulder dislocation, Tibial fracture, Talus, Upper limbs, Ulna.

INTRODUCTION

This is one of the most important chapters of this book. Since the book is designed to give medical students, practicing non-specialist physicians, and other healthcare professionals basic information on how to provide optimal services to pediatric, adult, and older patients with health concerns pertaining to this aspect of the skeleton, the author deemed it expedient to provide slightly more images in this chapter than in the others. Since the appendicular skeleton is about the part of the musculoskeletal system that enables human mobility, dexterity, self-protection, and self-care (among other functions), the bones that constitute the appendicular skeleton are especially important. They are so important that a significant injury to just one of the fingers or toes exerts a noticeable impact on any patient’s activities. The parts of the appendicular system that are described in this chapter are the upper limbs and the lower limbs. With regard to the upper limbs, the chapter covers normal shoulder joint, shoulder dislocation, osteoarthritis of the shoulder, fracture of the humeral shaft, greenstick fracture of the radius, fractures of the radius and ulna, and fracture of the phalanx. Pertaining to the lower limbs, the Chapter describes the following: normal hip joint, osteoarthritis of the hip, fracture of the femur, normal knee, osteoarthritis of the

knee, osteoarthritis of the knee with fractures of tibia and fibula, fractures of the tibia and fibula, and calcaneal spur.

Normal Shoulder Joint – Antero-posterior Joint

The shoulder joint is the glenohumeral articulation, and it is a significant articulation of the shoulder girdle. Unlike the pelvic girdle, which is in the midline of the human body, the shoulder girdles are laterally disposed. The main bony articulating parts of the shoulder joint are the head of the humerus and the glenoid cavity of the scapula. Other articulations accentuate the functionality of the shoulder joint; these are the sternoclavicular joint, the scapulothoracic joint, the acromioclavicular joint, and the coracoclavicular joint [1]. The two sternoclavicular joints are at the medial ends of the clavicles. The scapulothoracic joints are posterior, while the acromioclavicular joints and the coracoclavicular joints are lateral.

Normal Shoulder Joint – Antero-posterior View

The scapula (shoulder blade) is roughly triangular and is in the upper part of the thoracic region where it is precisely on the posterior surface of the rib cage [2]. The scapula articulates with the head of the humerus at the glenohumeral joint and the clavicle at the acromioclavicular joints bilaterally [2, 3]. The articulation of the scapula is maintained by ligaments and many muscles, which shield it from trauma that would ordinarily fracture this thin bone [2]. Scapular ligaments are the coracoacromial ligament, coracohumeral ligament, acromioclavicular ligament, and coracoclavicular ligament – in addition to the transverse scapular ligament. As the names of the ligaments suggest, most of them are attached to the coracoid process of the scapula [2].

Figs. (1, 2 and 3) are radiographs of the shoulder of a 20-year-old male.

The bones, joints, and soft tissues are within normal limits. The conclusion is a normal shoulder.

Shoulder Dislocation

Black arrow = Head of the humerus; Yellow arrow = Glenoid cavity of the scapula; White bracket = Normal position of the greater tubercle and neck of the humerus; Red arrow = Position of the greater tubercle and neck of the humerus in shoulder dislocation; Broken white arrow = Displacement of the proximal humerus in dislocation of the shoulder joint. Humeral head dislodgement from the scapular glenoid defines shoulder joint dislocation. Separations at the acromioclavicular and coracoacromial joints are not true dislocations of the

shoulder [4]. Reduction of an acute anterior dislocation of the shoulder entails an expeditious and careful replacement of the head of the humerus into the scapular socket [4 - 7]. Dislocation of the shoulder may occur during significant trauma or be related to the insufficiency of the support that the supporting elements provide to that shoulder [4]. Shoulder dislocation may be an anterior dislocation or a posterior dislocation. The patient should have an intraarticular injection for analgesia or conscious sedation using a short-acting agent. Post-operatively, there must be a repeat X-ray examination to confirm reduction [4].

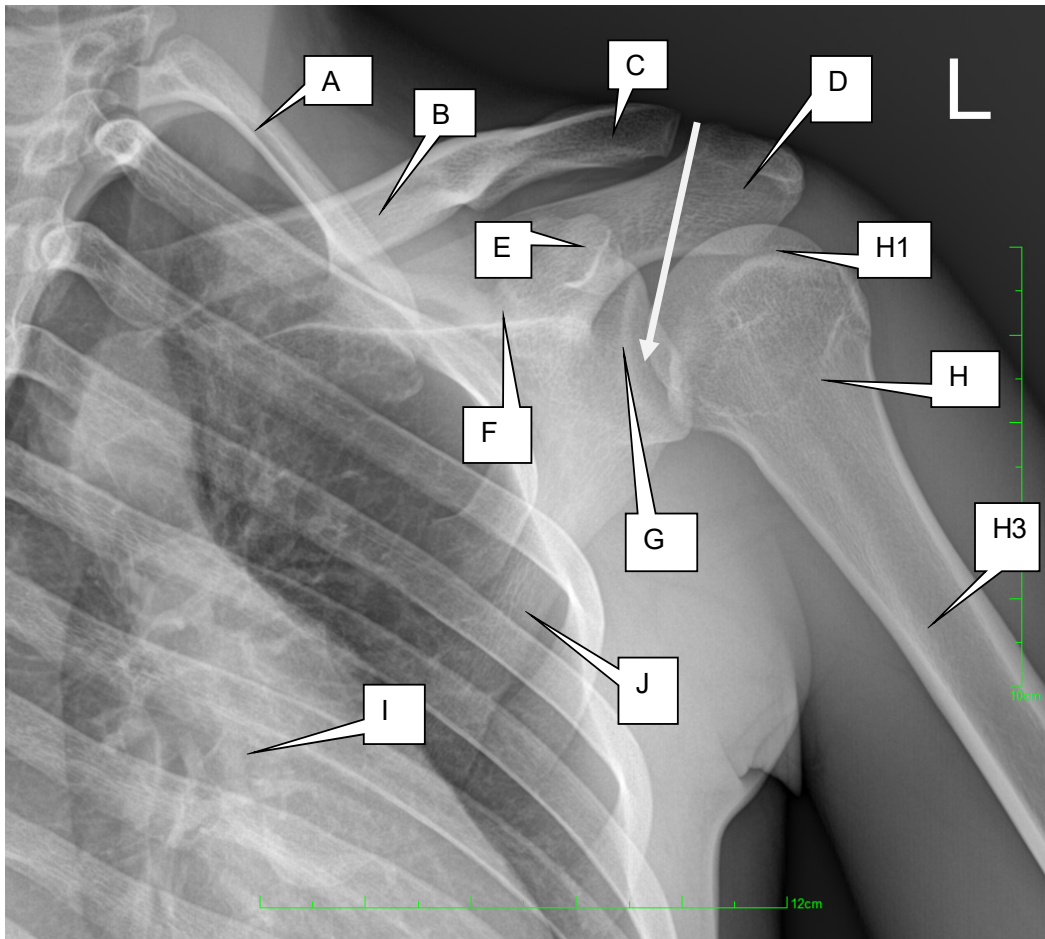


Fig. (1). A = 1st rib; B = Clavicle; C = Acromial (Lateral) end of the clavicle; D = Acromion process of scapula; E = Coracoid process of scapula; F = Scapular spine; G = Rim of the glenoid; H = H1 = Head of humerus; H2 = Neck of humerus; H3 = Shaft of humerus; I = Heart; J = Lateral border of the scapula; White arrow = Left glenohumeral joint.

CHAPTER 6

The Urinary System

Abstract: Inclusion of the urinary system in this short book on radiology is predicated on the fact that the urinary system helps the human body, according to this author, “to maintain physiological sanity.” So much enters the body through the gastrointestinal system, the skin, and the respiratory system, with the urinary system as the major system responsible for the excretion of metabolic products of food, drugs, and toxic substances. Accumulation of any of these products without a concomitant and expeditious excretion would put the human being at risk of disease (acute or chronic) and premature death.

Due to the complexity of the renal system, there may be congenital abnormalities just as there are many acquired abnormalities – the acquired abnormalities are not necessarily structural ab initio but may start as functional derangements that, over time, cause enough damage to cause structural changes.

Keywords: Ascending urethrography, ASU, Hysterosalpingography, Intravenous pyelogram, Retrograde urethrography, RUG.

INTRODUCTION

This chapter does not treat many conditions in the renal system, but these few investigations in the urinary system were selected and included to represent investigations on disorders in the system. They are intravenous pyelogram and retrograde urethrogram. The investigations require a series of images and not just one.

Intravenous pyelography is an investigation for visualizing the kidneys, ureters, and bladder [KUB] [1]. Preparation of the patient for intravenous pyelography should include the following:

During consultation, obtaining adequate information from the patient regarding allergy to iodine;

Checking the patient’s medical records to know about comorbidity, drugs taken currently, recently, and in the past – and if there has been any untoward reaction attributable to any of them.

Providing information to the patient to enable them to give informed consent in writing; this entails a simplified explanation of the procedure without using medical terms and jargon – if they are used, they must be explained.

Fasting, preferably overnight.

Mild laxatives like Bisacodyl suppositories are taken the night or day prior to the investigation.

On the day of the investigation, a female patient whose history or medical records indicate pregnancy should be protected with a shield so that the fetus is not subjected to radiation that can be avoided by this means. Just prior to the procedure, the patient should remove and keep aside jewelry and metal objects. The duration of intravenous pyelography may take longer than one hour if the patient's excretory capacity is less than optimal. The patient must be advised to be motionless during the procedure – this is a challenge for some patients [2].

Pathology in the urethra may be studied using contrast material injected from the distal end of the urethra, such that the visualization aid goes against the natural direction of passage of urine. This investigation is referred to as retrograde urethrography (RUG) or ascending urethrography (ASU). The image obtained from the study is a urethrogram. It may be required to study the posterior aspect of the urethra, and, in this case, it is better to make the patient void (urinate, or micturate) with the contrast medium already in the bladder. This latter study is indicated by various names, *viz.*: retrograde urethrography, micturating urethrography, or voiding cystourethrography [3].

Indications for retrograde urethrography include obstruction, strictures, and diverticula of the urethra. Others are poor urinary stream, urethral mucosal tumors, fistulae, and foreign bodies. Pelvic trauma may necessitate an urgent investigation to enable a determination of emergency treatment [3]. A well-performed retrograde urethrography (RUG) should locate the stricture, their number is more than one, the severity, and the length of the narrowed urethral portion; these are essential for determining the mode of treatment of the patient [4]. The first-line management of anterior urethral stricture currently favors urethroplasty using buccal mucosal grafts. Urethroplasty does not have the high rate of urethral stricture recurrence reported with other procedures like urethral dilation, internal urethrotomy, and urinary diversion [4].

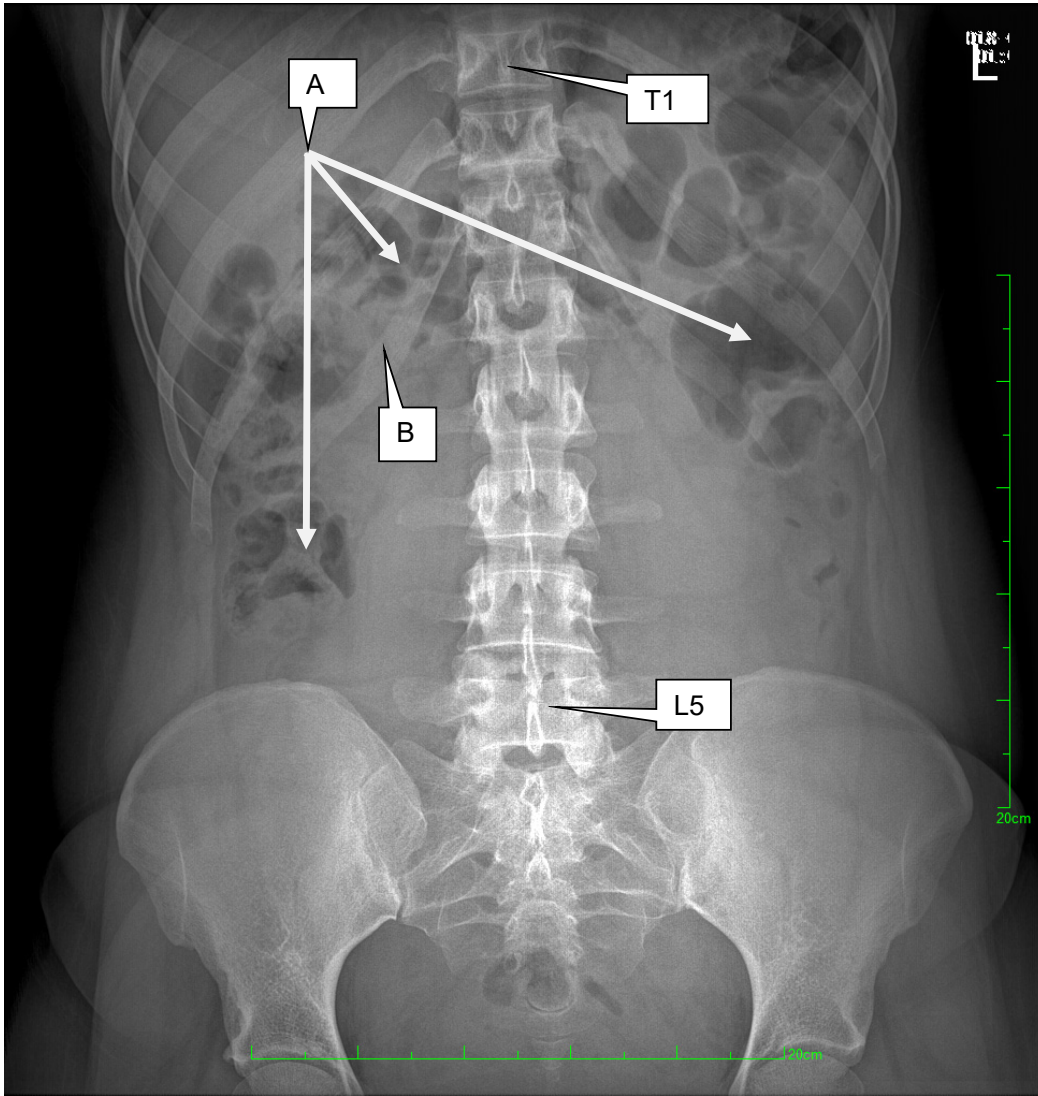


Fig. (1). An intravenous pyelogram with anatomic relationships. A and White arrows = Air in the ascending, transverse, and descending colon; B = Right 12th rib; T10 = Tenth thoracic vertebra; L5 = Fifth lumbar vertebra.

The Cardiovascular System

Abstract: Of the modalities for cardiovascular imaging, the oldest, simplest, and most affordable is chest radiography. One of the challenges with chest radiography is that some practitioners who request this investigation method still believe that they should rely on the specialist to provide them with reports of the images obtained. In developing countries, it is a common experience that the patient needs to return to the hospital or the center where the investigation was conducted and be on the queue to obtain the physical report. Thus, the administrative and logistical efforts become encumbrances that patients and the relatives of the extremely unwell have to bear. When the report on the radiograph, like chest radiograph, indicates “Normal chest findings” the patient either has a sense of relief (as a part of preemployment medical examination) or occasionally feels frustrated (like a patient for whom the physician expected a cardiac basis for their symptoms) as such patients may consider their money wasted for an investigation that was “unnecessary.” Inasmuch as a negative finding gives relief to the physician, it sometimes nudges the physician to request further investigations to find the reason for the illness. Pre-investigation, it is important for a physician to communicate the possible findings with the patient or well client. After the test, when the patient returns for a review, the doctor should ensure that the findings are explained to the patient, particularly the patient who shows interest in knowing as much as possible from the test results. Part of the above scenarios is why this brief Chapter on the cardiovascular system attends to medical imaging and approaches it from an easy-to-understand and easy-to-communicate stance. This way, medical students appreciate the relationship of radiology and clinical care with gross human anatomy, a pre-clinical subject in the medical school.

Keywords: Chest radiography, Computed tomography (CT) scanning, Electrocardiography, Magnetic resonance imaging, MRI.

INTRODUCTION

Chest radiography, electrocardiography, echocardiography, computed tomography (CT) scanning, magnetic resonance imaging (MRI), and positron emission tomography (PET) are examples of medical imaging of the cardiovascular system. This chapter provides representative examples of some of these techniques and the results from the investigation modalities are described in simple terms that encourage the medical student and physician to pass on the information confidently to their patients, parents of patients who are still minors,

authorized family members, and other caregivers who may need the findings to care for the patient after they return home from an outpatient consultation or after they are discharged from hospitalization.

The chapter commences with plain chest radiographs and continues with electrocardiograms and other images obtained during the medical imaging procedure. Where images are not still, the still versions are used in this chapter just for illustration purposes.

Cardiomegaly

Cardiomegaly is the abnormal enlargement of the heart, and it is readily demonstrable by the cardiac silhouette. This enlargement may also be occasioned by the radiograph being taken during the expiratory phase of respiration rather than full inspiration. Another cause is an image from an AP projection (view) rather than the PA view. The AP view in which the patient faces the X-ray machine and beam while the back is closest to the film tends to make the cardiac silhouette appear to be larger than it should be. It is like pointing a light at an object that is close to the wall and pointing when the same object is further away from the wall. The image captured further away is larger than the one with the object close to the wall. The heart is anterior in the chest wall, and when the film is at the back, the deflection of rays makes the heart appear larger in an AP projection. Other causes include pericardial effusion, a prominent fat pad in the epicardium, and an anterior mediastinal mass.

The cardio-thoracic ratio is the maximum horizontal diameter of the heart to the maximum thoracic diameter, and it should not exceed 0.50. In cardiomegaly, the ratio is more than 0.50 [1]. In other cases of enlargement of the cardiac silhouette, it is also more than 0.50. However, exceeding 0.50 may happen when the cardiac size is normal, *e.g.*, prominence of epicardial fat pad in obesity or chest radiograph taken during expiration. CTR should not be measured if the projection was AP – or, if measured, a slight increase over 0.50 should not be adjudged cardiomegaly; the reason is given in the previous paragraph. Using the posterior-anterior (PA) projection, a ratio that is more than 0.55 is indicative of cardiac chamber enlargement [2, 3]. Enlargement of the heart may be due to the following: Left ventricular enlargement, right ventricular enlargement, right atrial enlargement, and left atrial enlargement. In patients with long-standing uncontrolled hypertension, the increase in cardiothoracic ratio is due to left ventricular predominance [3].

Normal Chest Radiograph

Figs. (1-3) In this 24-year-old male patient, the radiographs show a normal heart, lung fields, and rib cage.

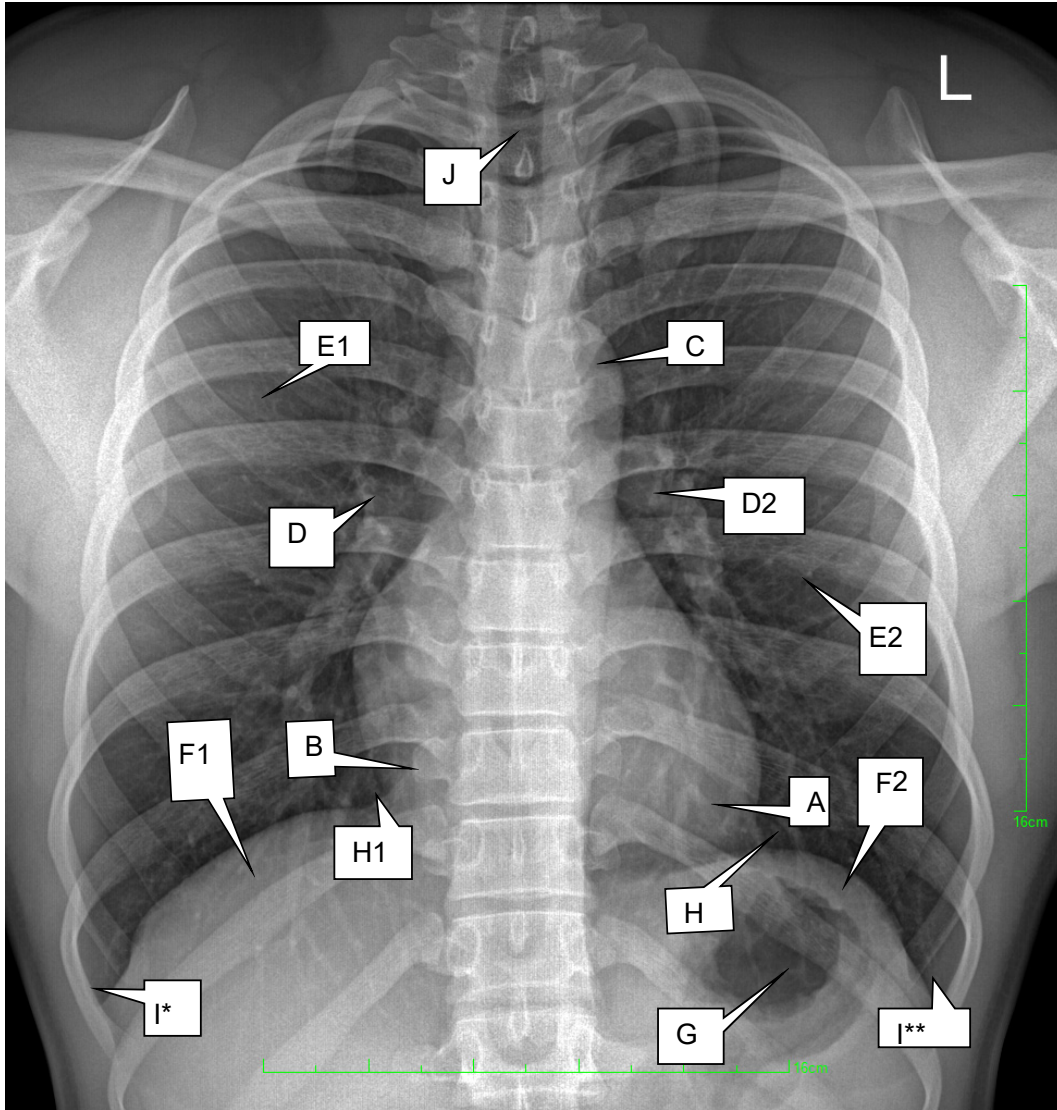


Fig. (1). This is a posterior-anterior radiograph of the chest of an adult male.
 A = Left ventricle; B = Right atrium; C = Arch of the aorta; D1 and D2 = Pulmonary vessels; E1 and E2 = Lung tissue; F1 and F2 = Right and left domes of the diaphragm; G = Gastric bubble; H1 and H2 = Right and left cardio-phrenic angles; I* = Right costo-diaphragmatic recess (costophrenic angle); I** = Left costo-diaphragmatic recess (costophrenic angle); J = Air in trachea – The trachea is central.

CHAPTER 8

The Gastrointestinal System

Abstract: The gastrointestinal system is an essential system not only for the nutrition of the human body but also for the absorption of medications that are used for the treatment of the numerous ailments that humankind is prone to. The food and drugs mentioned are the ones that are taken by the oral route and not the ones meant for intravenous alimentation or parenteral therapy.

The gastrointestinal system must be robust to carry out these functions mentioned briefly and treated simplistically.

The gastrointestinal system can be investigated by a variety of medical imaging techniques; these depend on the patient's symptoms, duration, findings on physical examination, presence or absence of comorbidity, first episode or recurrence of the symptoms and signs, whether the patient has undergone abdominal surgery (or not) in the past, and other determinants. Therefore, while one patient may require plain radiography, another may need barium meal (depending on the practice area in the world), and yet other patients with presentation referable to the gastrointestinal system may need endoscopy, CT scan, magnetic resonance imaging (MRI), or a combination of these.

Keywords: Barium meal, CT scan, Endoscopy, Magnetic resonance imaging (MRI), Plain radiography.

INTRODUCTION

The author of this chapter carefully selected conditions that physicians of first contact and medical students in their clinical years encounter in any country globally. The conditions that are addressed are not inclusive but representative of normal abdomen and pathologies in the abdomen. Apart from these conditions, the author has provided an illustration of each of the following important abdominal radiological signs that should be of interest to readers: Hepatic (Liver) edge sign, Absent liver edge sign, Double track sign, Kidney bean sign, Crescent sign, Double bubble sign, and Caterpillar sign. Other signs are Mushroom sign (Umbrella sign), Beak sign, Bird's beak sign, Shoulder sign, Target sign (Bull's eye sign, or Doughnut sign), String sign, Corkscrew sign, Cupola sign (Mustache sign, Saddlebag sign), and Rigler sign [1].

Normal Abdomen

Fig. (1): A = Ascending colon; B = Transverse colon; C = Descending colon; D = Sigmoid colon.

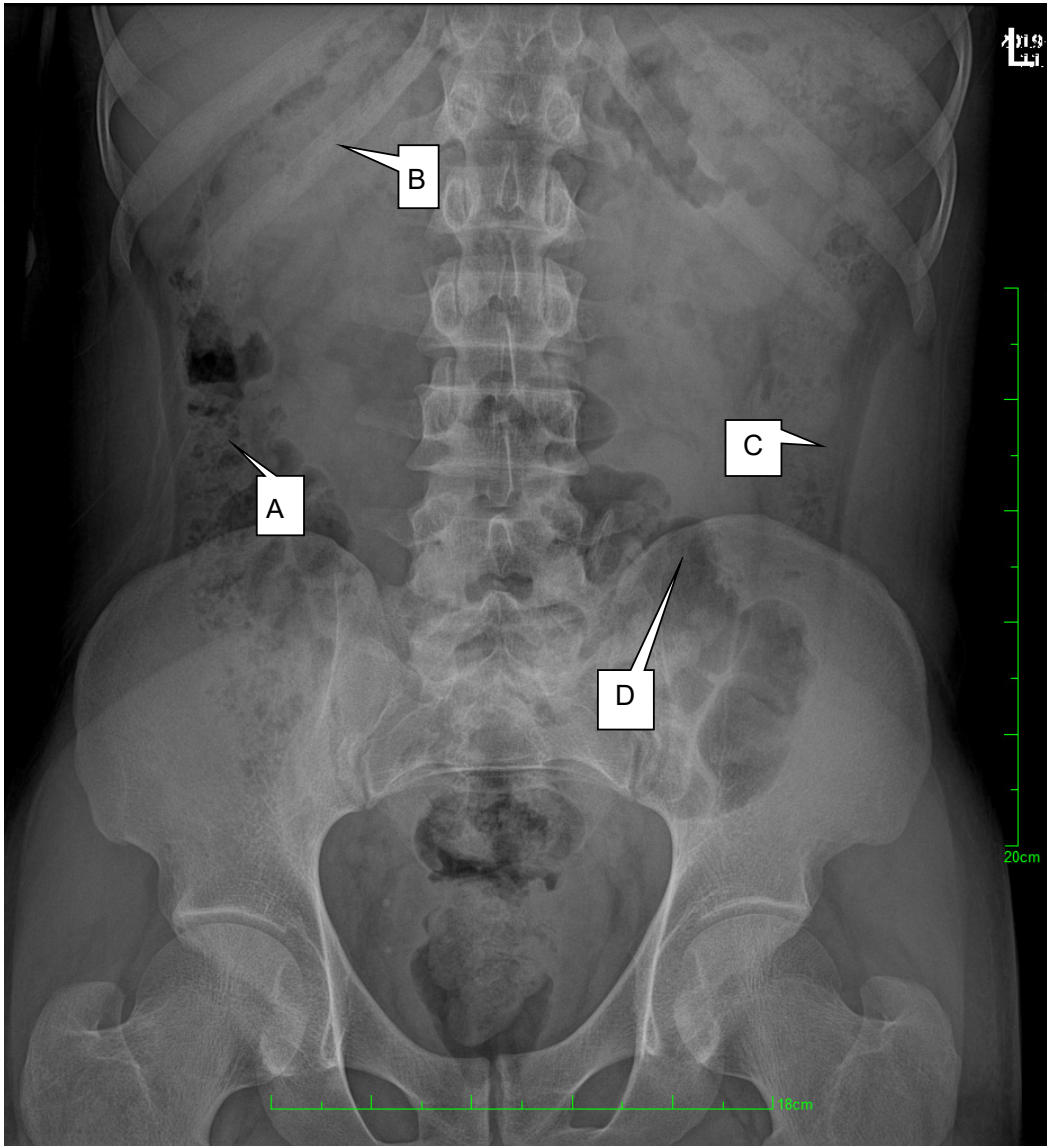


Fig. (1). Normal abdomen.

Labelling of this radiograph concentrates on the gas shadows representing the various parts of the large intestine (colon).

Fig. (2): A = Air in stomach; B1 and B2 = Air in transverse colon; White bold arrows = Right and left domes of the diaphragm. The two abdominal radiographs 15 and 16 are of a 20-year-old male. Bowel gas distribution, outline, and caliber of bowel loops are all within normal limits. Fecal matter is seen in the flanks and pelvis; in some patients, copious fecal matter may be a presentation of constipation [2]. No evidence of foreign bodies is seen. The findings are of a normal abdomen.

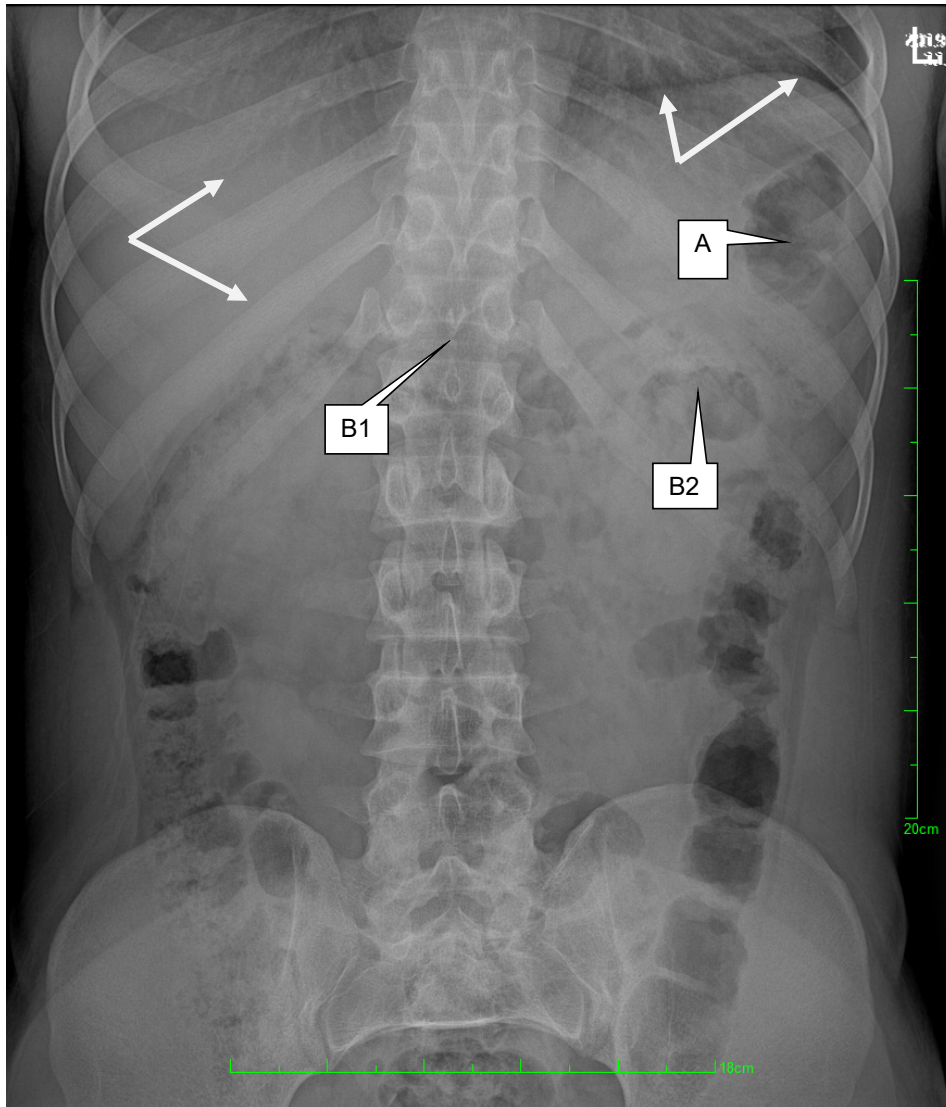


Fig. (2). Normal abdomen.

The Reproductive System

Abstract: For the perpetuation of the human species, the reproductive system is especially important. For couples who choose to procreate, it is a matter of concern if (or when) either of them has health challenges that could make the desire unachievable or stand a low chance of actualization. Without assisted reproduction, both parties must be found fit otherwise, now more available and accessible procedures in many countries are a viable alternative. This chapter does not attend to the theory and practice associated with conception, contraception, multiple pregnancies, antenatal care, normal and abnormal presentations, labor and childbirth, cesarean section and other procedures, or infertility and the disease conditions in the domain of gynecology. The emphasis of this chapter is only on medical imaging pertaining to this essential system. The chapter addresses some of the common investigations in the area of radiology and shows how and why a medical student and practicing physician should be adept at choosing which investigation to request while considering the emotional issues associated with the health condition, the investigation, and the waiting period from carrying out the investigations to obtaining the desired treatment results.

Keywords: Hysterosalpingogram, Hysterosalpingography, Mammography, Mammogram, Ultrasonography, Ultrasound scanning.

INTRODUCTION

A hysterosalpingogram entails injecting a contrast dye into the uterus. Its primary utility is the visualization of the endometrial cavity and fallopian tubes. This radiographic study was carried out to assess a couple with infertility, *i.e.*, the female factor [1]. Endometrial integrity and tubal patency are two of the conditions to be confirmed alongside other investigations on the female. There are male factors that could be responsible for infertility, and these are assessed in the male partner. It is a diagnostic imaging modality primarily utilized in assessing female infertility.

Before hysterosalpingography is performed on a patient, informed written consent should be obtained from the patient. The information that the patient should have and give is important. For example, the patient should be made aware that there is a negligible risk of infection, perforation of the uterus, and reaction to the iodine component of the contrast medium. Other considerations are that the procedure

may take place in an undiagnosed pregnancy, there would be exposure to low-dose radiation, and that since the contrast medium is oil-based, there is some risk of oil embolism. However, some of these may be ruled out when obtaining a history from the patient, like allergy to iodine; a history of food allergy regarding seafood is now considered not very pertinent as a positive history does not contraindicate carrying out the procedure [2]. However, all standard precautions must be put in place prior to the procedure. Regarding exposure to radiation, the patient should be informed that the radiation dose that the ovaries are exposed to during hysterosalpingography is minimal. The risk of concomitant pregnancy is removed by obtaining a history of the client's last menstrual period (LMP), and the more certain the date, the better. Where there is doubt, the procedure may be deferred, or tests that are sensitive enough to detect early pregnancy are carried out. Some patients for this investigation are almost petrified with the fear of pain; this happens when they seek or obtain information from women who have undergone the procedure. The pain is usually bearable, especially when the procedure is carried out carefully and by a professional who is experienced with hysterosalpingography. Still on pain, this is a subjective feeling, and the person performing the investigation cannot predict the patient's response to pain.

HYSTEROSALPINGOGRAM SERIES

Plain Anteroposterior Radiograph of the Pelvis

Fig. (1): A = L4/L5 disc space; B = Sacrum; C = Right ala of the sacrum; D = Left sacroiliac joint; E = One of the four sacral foramina; F = Recto-sigmoid; Straight white line in-between arrows = Characteristic of female pelvis at the inferior rami of the pubis.

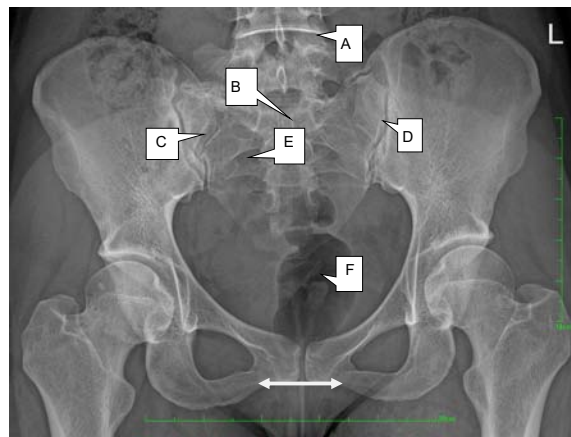


Fig. (1). Plain anteroposterior radiograph of the pelvis.

Plain Radiograph of the Pelvis

Fig. (2): A = 5th lumbar vertebra; B = Pubic bone (pubis); C = Pubic symphysis (Symphysis pubis); D = Obturator foramen; White in-between two arrows = Line across the iliac crests, normally demarcating the disc space between L4 and L5. In this patient, the image demonstrates a downward tilt to the right. Yellow arc and white arrows = Indicating the pelvic inlet.

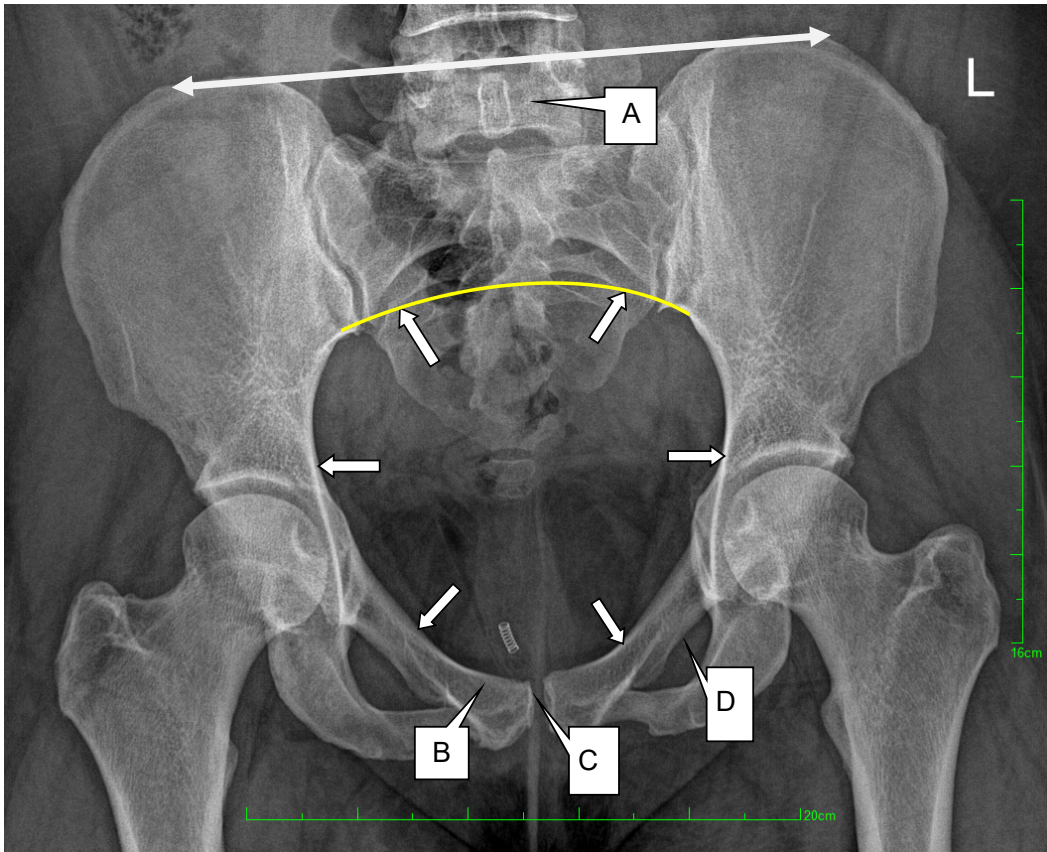


Fig. (2). Plain radiograph of the pelvis.

HSG Instruments

Fig. (3): A = Cusco speculum; B = Tenaculum forceps; C = Leish-Wilkinson cannula tip.

CHAPTER 10

The Nervous System

Abstract: The purpose of this chapter is to document some of the numerous clinical events that take place in the nervous system. The human nervous system is the most advanced among the members kingdom. It is precisely because of this advancement that has put humankind at the intellectual epitome in the entire universe. While humans are not the biggest or the toughest, they are the most enterprising and the ones who challenge the status quo of the universe.

Unfortunately, the nervous system and its organs are not immune to damage and diseases, and it is imperative for these negative events and disease processes to be identified and stemmed promptly. This chapter deals with the fundamentals of medical imaging which is a great tool in achieving this goal.

Keywords: Brain, Brain stem, Cerebral cortex, Skull, Spinal column, Spinal cord, Ventricles.

INTRODUCTION

This chapter briefly addresses the most common conditions in the skull, brain, and spinal column. A few normal findings are presented, and the others are the abnormal conditions. The conditions that this book concentrates on are the ones that are linked to patients presenting in hospitals with emergency conditions. This is a global phenomenon. In the advanced countries where practice settings make the practitioner have ready access to the imaging modalities that can identify the disease entity promptly, doctors readily determine the correct course of action to save the patient's life or minimize morbidity. In many developing countries, the specialized imaging techniques are unavailable, and where they are available, they are insufficient to meet the need [1 - 4]. The most worrisome is that even when public medical facilities have been provided with this equipment, qualified personnel to operate the equipment and radiologists to interpret the images may be few and difficult to access when they are needed. The human factor is, therefore, a major setback in some medical practice settings, but this is further complicated or compromised by erratic electric power supply, which sometimes comes with damaging voltage fluctuations that the hi-tech equipment was not designed to be subjected to.

Doctors in developing countries long for the days when medical practice in their part of the world will be “a level playing field” with the practice of their colleagues, where encumbrances are minimal and the best service can be rendered to most patients most times in every medical practice setting.

Anatomy of the skull and the brain is the area to focus on for a clear understanding of the challenges that occur in the nervous system. The same thing applies to the anatomy of the spinal column, for this part of the nervous system is essential for linking the rest of the body with the skull and brain.

This chapter, consequently, commences by taking the reader back to the anatomy of the skull. The anatomy of the spinal column was treated under the axial skeleton (Chapter 4).

This chapter does not address the gross anatomy of the brain and the spinal cord, but aspects of the brain and spinal cord are indicated in the advanced demonstrative images for the benefit of the reader.

Fig. (1): An anteroposterior (AP) radiograph of the skull. White arrows = From top: sagittal suture, coronal suture, lambdoid suture; Yellow bracket = Frontal air sinuses; Black arrow = Crista galli; Broken yellow arrow = Cribriform plate of the ethmoid bone; Broken white arrow = Right ethmoidal air sinus; Blue arrow = Nasal septum; Red arrow = Inferior nasal concha; A = Orbit; B = Maxillary sinus; C1 = Ramus of mandible; C2 = Body of mandible; D = Teeth.

The Normal Skull

Fig. (2): is a radiograph showing the lateral view of the skull and a part of the cervical spine: White arrows = Coronal suture; Broken white arrow = Lambdoid suture; Red arrow = Sphenoidal sinus; Yellow arrow = Palatine process of maxilla; Broken yellow arrow = Coronoid process of mandible; A = Frontal sinus; B = Greater wing of the sphenoid; C = Sella turcica; D = Anterior clinoid process; E = Posterior clinoid process; F = Mastoid air cells; G = Maxillary sinus; H = Roots of teeth in maxilla; I = Body of mandible; J = Hyoid bone; K = Angle of mandible; L = Anterior arch of the atlas (C1); M = Condyle of mandible.

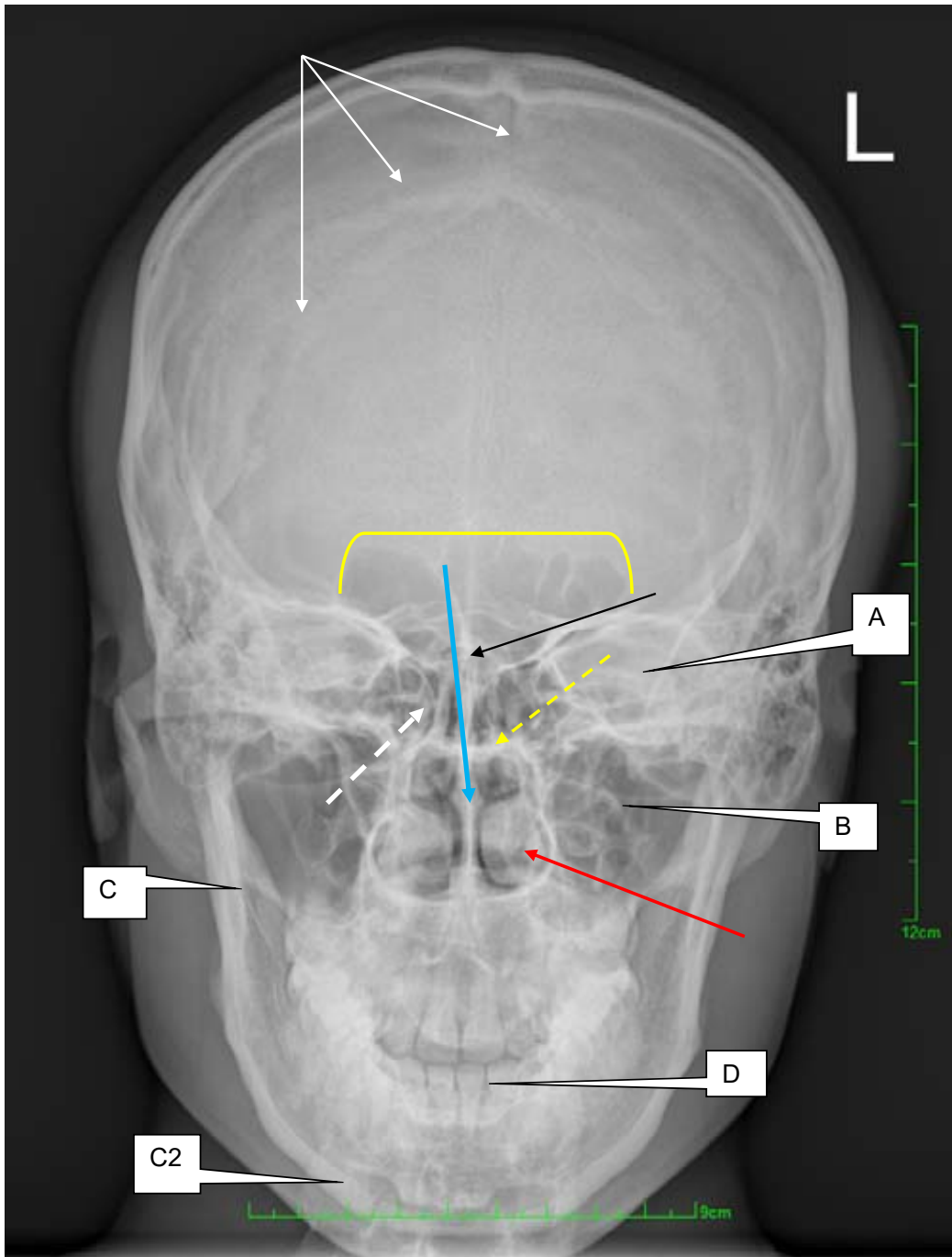


Fig. (1). An anteroposterior (AP) radiograph of the skull.

CHAPTER 11**Hematopoietic System, Endocrine System, and Miscellaneous Diseases**

Abstract: This chapter is occasioned by the need to include a few more conditions to provide this book with further variety of cases, and at the same time maintain the size envisioned for this book.

Keywords: Doppler ultrasonography, Ear, ENT, Nose, Otorhinolaryngology, Pituitary macroadenoma, Rhinitis, Sinusitis, Throat.

INTRODUCTION

The contents are focused on topics in the otorhinolaryngology, the vascular system, and the endocrine system (specifically the pituitary gland). The first part of the Chapter is devoted to ear, nose, and throat (ENT, otorhinolaryngology), and Figs. (1-8) describe sinusitis and rhinitis, which are two common conditions that affect pediatric and adult patients. Radiographs are used to demonstrate the gross anatomy and deviations from the normal condition in sinusitis and rhinitis. Figs. (9-11) use gray scale and color Doppler ultrasonography to study the popliteal vessels. In Figs. (12-13), the thyroid gland is studied using gray scale and color Doppler ultrasonography. In Fig. (14), color Doppler interrogation of the testicles shows abnormal findings. Figs. (15 and 16) show the findings in pituitary macroadenoma.

The features of acute sinusitis include a partial or total opacification of the affected sinus (usually the maxillary sinuses); this depends on the severity of the infection and the time interval between the onset of symptoms and presentation for examination and investigation. Another feature is the presence of an air-fluid level, which is obvious in the maxillary antra. There is also thickening of the affected sinus mucosa [1, 2]. Although air-fluid levels are characteristic in acute sinusitis, this finding is only found in less than 50% of patients [3, 4]. Other features of acute sinusitis are not limited to patients with acute sinusitis and may be present in asymptomatic individuals [3]. Patients with chronic sinusitis have an involvement of the ethmoid sinus [1]; the patients may complain of heaviness and pain over the ethmoidal sinuses, which are posterior to the bridge of the nose,

close to the medial aspect of the eyes. The acute and chronic forms of sinusitis may be assessed by radiography; while this form of investigation may offer satisfactory information in patients with maxillary sinusitis, ultrasonography, CT scanning, and magnetic resonance imaging provide clearer images than radiography and are especially valuable in case of the diagnosis and review of patients with frontal, ethmoidal, and sphenoidal sinusitis.

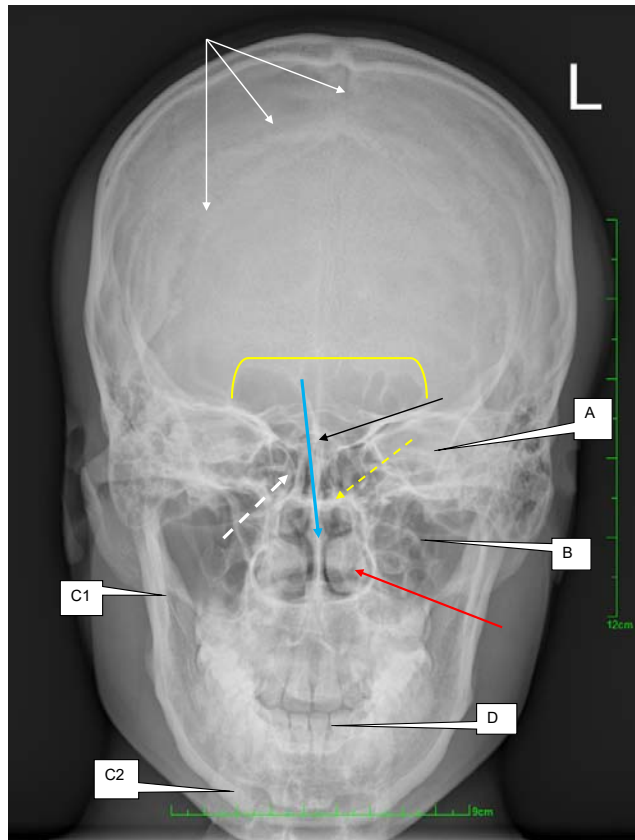


Fig. (1). Antero-posterior radiograph of the skull.

Fig. (1) White arrows = From top: sagittal suture, coronal suture, lambdoid suture; Yellow bracket = Frontal air sinuses; Black arrow = Crista galli; Broken yellow arrow = Cribriform plate of the ethmoid bone; Broken white arrow = Right ethmoidal air sinus; Blue arrow = Nasal septum; Red arrow = Inferior nasal concha; A = Orbit; B = Maxillary sinus; C1 = Ramus of mandible; C2 = Body of mandible; D = Teeth.

Fig. (1) demonstrates some of the features of the normal skull. The view is anteroposterior.

White arrows = Coronal suture; Broken white arrow = Lambdoid suture; Red arrow = Sphenoidal sinus; Yellow arrow = Palatine process of maxilla; Broken yellow arrow = Coronoid process of mandible; A = Frontal sinus; B = Greater wing of the sphenoid; C = Sella turcica; D = Anterior clinoid process; E = Posterior clinoid process; F = Mastoid air cells; G = Maxillary sinus; H = Roots of teeth in maxilla; I = Body of mandible; J = Hyoid bone; K = Angle of mandible; L = Anterior arch of the atlas (C1); M = Condyle of mandible.

Figs. (1 and 2) are anteroposterior and lateral view radiographs of the skull of a young adult male aged 24 years. The cranial vault, sutures, and Sella turcica are within normal limits. The two radiographs show a normal skull.

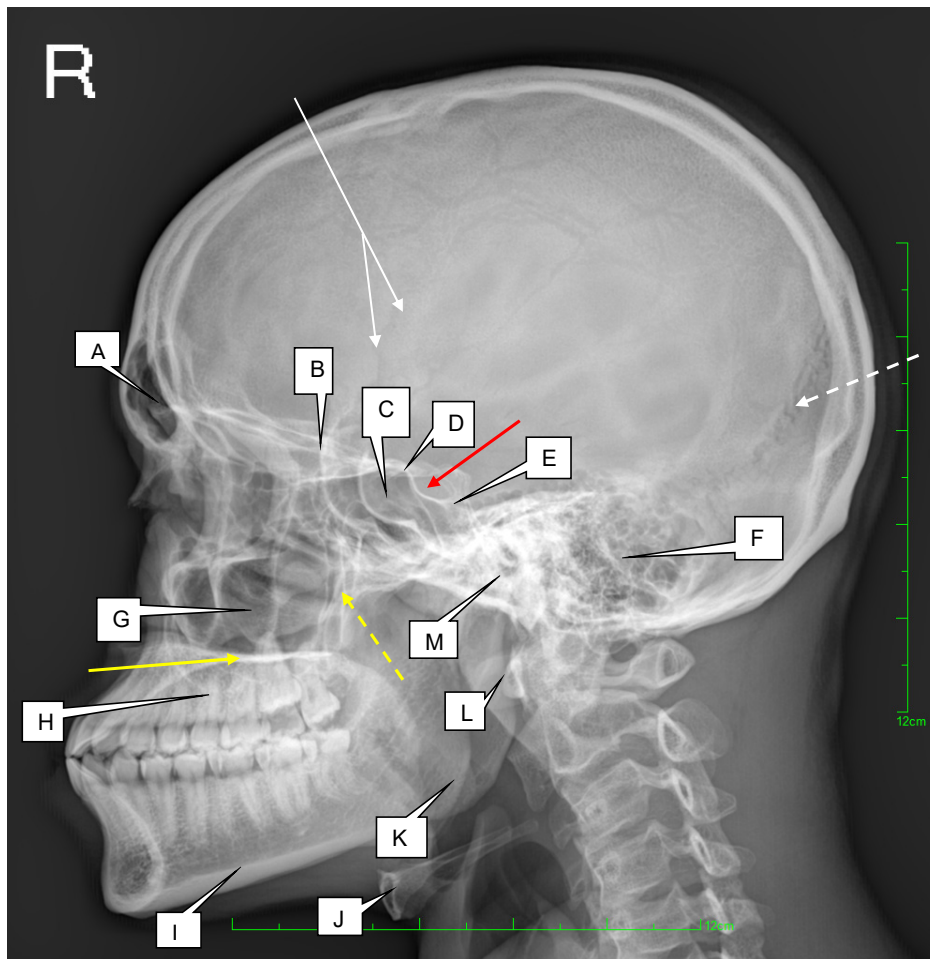


Fig. (2). Lateral view radiograph of the skull of a young adult.

Multiple-Choice Questions

Abstract: In this book, various modalities that are used for medical imaging are discussed with examples selected from radiography, ultrasonography, computed tomography scanning, and magnetic resonance imaging.

A part of the body that has been exposed to medical imaging right from the earliest times of radiography is the musculoskeletal system. Incidentally, the axial skeleton and the appendicular skeleton constitute one of the systems of the body that are most commonly exposed to X-rays; this happens in the production of regular plain radiographs and the enhanced forms of radiography, like the use of contrast media and fluoroscopy. X-rays are also used in CT scanning and magnetic resonance imaging.

It is not possible to achieve the desired size of a physically portable and an electronically readily navigable book by including multiple-choice questions on every body system. This goal has limited the contents of this short chapter on MCQs to a small segment of orthopedic surgery. The contents are on the fundamentals only.

Keywords: Acute osteomyelitis, Dactylolysis spontanea, Paraspinal abscess, Prolapse of the intervertebral disk, Talipes equinovarus.

INTRODUCTION

This chapter contains fifty multiple-choice questions of the single best answer (SBA) format. This is one of the most common and best accepted types of MCQs in the field of medicine. For this book, the MCQ unit is in two parts *viz.*, the question and the answer options. The question is really a question that most frequently starts with the word “Which” and ends with the question mark, “?”. This “body” of the MCQ is important, and the reader should pay close attention to each question, for there are variations in the way they are presented. Mostly, they are set in the positive, meaning that what is correct is the answer; at other times, they are crafted in the negative – in which case what is wrong is the Answer, and the leads are words like, “not” and “incorrect.” The stem occasionally starts with a statement that may be a short clinical scenario; this is followed by the usual question just described. It is important for the reader to keep in mind that more than one option may be, or appear to be, correct, but for each MCQ, only the best option is the answer. Regarding the four available options, the most important

clues are: Do not rush through them. Do not preempt their intent. Do not make them more difficult or complicate them by looking for any “catch” for there is none, and note but do not pick the very first likely answer until you have gone through the remaining three options.

The multiple-choice questions are straightforward, and 80% of them are of the lower rung of Bloom’s taxonomy; that way, every reader (student and healthcare practitioner) will enjoy the questions. Answers and Notes are provided; some of the notes are robust and others that deal with the most basic have only one to five lines. The comment is not always an explanation for the answer, as it sometimes provides additional information on the topic of the MCQ or a differential diagnosis. Occasionally, the author provides a few References to support the information provided.

Guide: Each MCQ consists of the stem (the question) and four options. Only one of the options is the answer. One or more options may be correct, but the best option is the answer. Choose only the best option.

1. With regards to a patient on whom a diagnosis of acute osteomyelitis is made, which of the following statements is correct?

- A. It affects adults more than children.
- B. Swelling of the bone is a common feature.
- C. The diaphysis is the usual site of onset of hematogenous infection.
- D. There is ischemia of a portion of the bone.

2. Of the characteristics of acute osteomyelitis, which of the following is excluded?

- A. Reduced movement of a nearby joint.
- B. Depressed periosteum.
- C. Formation of sequestrum.
- D. Formation of involucrum.

3. Which of the following is *not* expected as a common complication of acute osteomyelitis?

- A. Pulmonary embolism.
- B. Chronic osteomyelitis.
- C. Acute septic arthritis.
- D. Destruction of the epiphyseal plate.

4. With regards to septic arthritis, which of the following statements is correct?

- A. Fluid from the affected joint has a clear color.
- B. Complete resolution of the inflammatory process is a rarity.
- C. Staphylococci are a common cause.
- D. Joint pain is a minimal presenting symptom.

5. Which of the following organisms is *not* expected as the etiological agent in a patient with suppurative septic arthritis?

- A. *Brucella abortus*.
- B. *Borrelia burgdorferi*.
- C. *Streptococcus viridans*.
- D. Histoplasma species.

6. Which of the following statements about osteoarthritis is correct?

- A. It may be a sequel to a previous joint injury.
- B. It does not affect large joints.
- C. It is a diagnosis limited to the elderly and under-fives.
- D. It is not usually encountered by general physicians.

7. Regarding osteoarthritis, which of the following statements is correct?

- A. The shoulder joint is more prone to osteoarthritis than the knee joint.
- B. Uncontrolled obesity may result in osteoarthritis.
- C. A mid-shaft fracture of the tibia is more likely to lead to osteoarthritis than a condylar fracture.
- D. The cartilage space is increased.

8. With respect to spondylosis, which of the following statements is correct?

- A. It may require physiotherapy as part of the treatment.
- B. It affects the thoracic region much more than the lumbar region.
- C. It features the spurring of the spinous processes of vertebrae.
- D. Non-steroidal anti-inflammatory drugs are part of inappropriate treatment.

9. Which of the statements about Pott's disease is incorrect?

- A. It is synonymous with tuberculosis of the vertebral spine.
- B. It does not occur in patients who have had pulmonary tuberculosis.
- C. Spinal pain is a presentation.
- D. Gibbus is a known feature.

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