1 Recognizing Anything

The “Colorful” World of Radiology
- It helps to think of radiologic images in “color.”
- The colors of radiologic images, in most cases, will be black, white, and varying shades of gray, but nonetheless they are still colors.
- The denser an object is, the more x-rays it absorbs, and the “whiter” it appears on radiographic images.
- Bone is the densest naturally occurring tissue.
  - It absorbs the greatest amount of x-ray and appears white on radiographs.
- Metal is even denser (whiter) than bone and essentially absorbs all x-rays, but metal does not occur naturally in humans.
  - Things like bullets or artificial hip replacements are metal density and will appear whiter than any other object on a conventional image (Fig. 1 1).
- The less dense an object is, the fewer x-rays it absorbs, and the “blackest” it will appear on radiographs.
  - Air absorbs few or no x-rays and appears the blackest on a radiograph.
- In conventional radiography, the terms opaque, nonopaque, dense, and lucent are used to describe the density of a structure relative to its surrounding tissue.
  - These terms do not specifically identify any particular disease (hundreds of diseases may produce lucencies and many hundreds more produce opacities) but rather define a lesion’s density relative to its surroundings.
- Here are some examples of how different densities are described:
  - A hole in a bone (remember, the bone itself is white) will appear blacker than the rest of the bone and is said to represent a lucency in the bone (see Fig. 21 21).
  - A fracture through a bone is usually blacker than the surrounding bone and is said to represent a lucency in the bone (see Fig. 22 7).
  - A large pneumothorax will contain no lung markings and may make the affected hemithorax appear blacker or more lucent relative to the normal hemithorax (see Fig. 9 10).
  - A large pleural effusion will absorb more x-rays than normally a rated lung and will make the affected hemithorax appear whiter or more opaque than the normal hemithorax (see Fig. 7 9).
  - Calcified gallstones visible on a conventional radiograph of the abdomen will be whiter than their surrounding tissues and are said to be opaque calculi (Fig. 1 2).

A Systematic Approach: The “Truth” About Systems
- Some look at imaging studies such as chest radiographs from the outside of the image to the inside of the image; others look at them from the inside out or from top to bottom.

Figure 1 1. Bullet in the chest. The dense (white) metallic foreign body in the region of the aortopulmonary window resembles a bullet because it is a bullet (black and white closed arrows). It is much denser (whiter) than the bones, represented by the ribs, clavicles, and spine (open white arrows). Two views at 90° angles to each other, such as these frontal (A) and lateral (B) chest radiographs, are called orthogonal views (see Chapter 2). With only one view, it would be impossible to know the location of the bullet. Orthogonal views are used throughout conventional radiography to localize structures in all parts of the body.

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• This is not magic; this ability comes only with experience and one other very important factor.
• Truth three: You are not an experienced radiologist, so you are not quite ready to use the “gestalt” approach.
• Truth four (this is the last one): The “one other very important factor” is knowledge.
• If you don’t know what you are looking for, you can stare at a radiograph for hours or even days or, in the case of the lateral chest radiograph, you can ignore an image entirely and the end result will be: you won’t see the findings.
• There is an axiom in radiology: You only see what you look for and you only look for what you know.
• So, if you don’t know what to look for, you will never recognize the finding no matter what system you use or how long you stare at it.
• That’s why you’re reading this book (isn’t it?): so you know what to look for and so that you’ll recognize it when you see it. Knowledge!

Terminology
• ‘Oh no,’ you say, ‘not the terminology section. Let me skip to the good parts.
• You can do that: just remember where this section is because you may have to refer to it later.
• Like politics, all terminology is local.
• Follow the terminology conventions used in your hospital or, alternatively, the person rendering your course grade, even if those conventions are different from what is described here.
• Here are the terminology conventions used in this book:
• Image: a good, all around term that can be used to describe any type of rendering of a radiologic examination.
• It works for all modalities; use it freely.
• You could say you were looking at an “image of the abdomen on a conventional radiograph,” or a “CT (computed tomographic) image of the abdomen,” or an “ultrasound image of the abdomen,” and so on.
• Try not to use the word picture in radiology: image will make you sound much smarter.
• X-ray: seems like an easy enough term, but its use is the subject of some controversy among terminology toughies
• Technically, an “x ray” is the invisible form of energy that helps produce the image.
• The image you are looking at or holding in your hand is technically not an “x ray” you can’t see or hold x rays.
• Fact: Many people (including us) use the term x-ray to refer to the actual image and not just the invisible rays and we have not been struck down by lightning for doing so.
• In this book, we will usually use the term radiograph to refer to the actual image you are viewing, but we all know that when someone says they are going to “look at the chest x rays” on Mr. Jones they are not intending to conjure up Roentgen’s mysterious rays but the radiographic images of Mr. Jones’ chest.
• **Film**: once the only way to view an image was on a piece of film which was then placed on a lightbox or viewbox (almost always backward or upside down if the film placement was being done as part of a movie or TV show).
• **Film**: is still the viewing medium in many clinics and departments of radiology.
• If you are using film to view your images, remember that when you place the film on the viewbox, you and the patient are always looking at each other face to face.
  - That is, the patient’s right side, whether it is on conventional radiographs or a CT scan, is on your left side and the patient’s left side should be on your right side.
  - This is the convention by which radiographs are viewed no matter what position the patient was in when the image was exposed.
• With the advent of PACS (see below), the computer monitor replaces film.
• **Cassette**: a cassette is the flat device that looks like a huge iPod that holds either a piece of film or a special digital plate in which x rays and light combine to produce a latent image that will become visible when it is processed in one of two ways, depending on whether the cassette contains film or contains a digital phosphor plate without film.
• If the cassette contains film, the film will be removed from the cassette in a darkroom (or by something called a **daylight loader** that simulates a darkroom) and sent through an automatic processor that contains series of chemicals that will develop the image, make it visible to the human eye, and fix it permanently on the film.
  - A new, unexposed piece of film will then be loaded into the cassette and the cassette will be ready for the next exposure.
• If it is a digital cassette and contains no film, it will be processed through an electronic reader that will decipher the electronic image stored on the phosphor plate in the cassette and transmit that digital image to another system to store it.
  - The electronic image in the cassette is then “erased” and the cassette is used again and again.
• **Computed radiography (CR) and PACS**: uses the kind of digital cassettes described above.
• Computed radiography uses the same x-ray equipment that film based cassettes use except that a digital cassette is substituted for one containing film.
• The electronic images so obtained are almost always viewed on and interpreted from computer monitors and stored in a large database archived by patient name, date of birth, type and date of study, etc. for future retrieval.
• **Computer-based system that archives and stores the images for later retrieval** is called a picture archiving, communications, and storage system, known by the acronym PACS.
  - In this case, using the term **picture** probably seemed like a good idea since using the word **image** or **x-ray** would have resulted in acronyms that were impossible to pronounce (**XACS**).
• **Radiograph**: technically the physical representation of the image x-rays help produce, as in chest radiograph.
• But we all know that the term chest x-ray transmits the same meaning to most people, and even though many radiographs today are viewed electronically and not on film, most people use the terms radiograph and film and x-ray interchangeably to refer to the image we view, as in chest radiograph or chest film or chest x-ray. Confused yet?
• **Plain films** are images produced through the use of x-rays but without added contrast material like barium or iodine.
• We may substitute the term **conventional radiographs** for the term **plain films** and even though their meanings are technically slightly different, if you don’t tell anyone, we won’t either.
• Besides, the term conventional radiographs makes them sound more exotic and difficult to interpret than does the term **plain films**.
• **Study** or **examination**: used interchangeably, they refer to a collection of images that examine a particular part of the body or system, as in “double contrast study of the colon” (a series of images of the colon using air and barium and produced through the use of x-ray) or, an “MRI (magnetic resonance imaging) examination of the brain” (a collection of images of the brain using MRI to produce the images).
• **Contrast material**: usually something that is administered to a patient in order to make certain structures more easily visible (frequently referred to as contrast).
• The most widely used examples of radiologic contrast materials include liquid barium, which is administered orally for upper gastrointestinal (UGI) examinations and rectally for barium enema (BE) examinations, and iodine, which is administered intravenously for contrast enhanced CT scans of the body.
• There are also contrast agents used for MRI and ultrasound.
• **Dye**: the lay term for contrast, as in “they gave me dye for my kidney x-ray and I thought I would die.”
• Although contrast is the better term, many patients, and some radiologists in explaining tests to patients, use the term dye.
• Don’t use the word dye unless you are talking to a patient explaining a test: use the term contrast or contrast agent.
• **Flat plate**: an archaic, but still used, term meaning a conventional radiograph or plain film of the abdomen, almost always obtained with the patient lying supine.
• This term is left over from the pioneer days of radiology before film was used as the recording medium and the image was produced on a flat, glass plate.
• **Wet reading**: another archaic term still used sometimes to refer to an immediate or “stat” interpretation of a study.
• The term derives from the manner in which radiographs were originally processed by manually moving the...
radiograph through a series of tanks containing photographic chemicals.

- A *wet reading* was one that was done more quickly, before the liquids on the radiograph actually dried.

- **White and black**: these are not radiologic terms, but almost every modality displays its images in white, black, and various shades of gray (see “The ‘Colorful’ World of Radiology” earlier in this chapter).

- Unfortunately, the specific terms used to describe what appears as white on an image and what appears as black on an image change from one modality to another.

- Table 1-1 is a handy chart that describes the interpretations of black and white in various modalities.

- **“En face” and “in profile”**: used primarily in conventional radiography and barium studies.

- When you look at a lesion directly “head on,” you are seeing it *en face*.

- A lesion seen tangentially (from the side) is seen *in profile*.

- Only a sphere, which, by definition, is perfectly round in every dimension, will appear exactly the same shape no matter what plane in which it is viewed (e.g., a nodule in the lung) (Fig. 13).

- Naturally occurring structures, whether normal or abnormal, of any shape other than a sphere will appear slightly different in shape if viewed *en face* or *in profile*.

**Table 1-1**

<table>
<thead>
<tr>
<th>Modality</th>
<th>Terms Used for “White”</th>
<th>Terms Used for “Black”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional radiograph</td>
<td>Increased density opaque</td>
<td>Decreased density; lucent</td>
</tr>
<tr>
<td>Computed tomography (CT)</td>
<td>Increased attenuation; hyperintense or hyperdense</td>
<td>Decreased attenuation; hypodense</td>
</tr>
<tr>
<td>Magnetic resonance imaging (MRI)</td>
<td>Increased signal intensity</td>
<td>Decreased signal intensity</td>
</tr>
<tr>
<td>Ultrasound (US)</td>
<td>Increased echogenicity; sonodense</td>
<td>Decreased echogenicity; sonolucent</td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td>Increased tracer uptake</td>
<td>Decreased tracer uptake; photopenic</td>
</tr>
<tr>
<td>Barium studies</td>
<td>Radiopaque</td>
<td>Nonopaque; radiolucent</td>
</tr>
</tbody>
</table>

- This is not an easy concept to grasp because it involves making a mental reconstruction of a three-dimensional object from the two-dimensional projections conventional radiographs provide.

- For example, a disk shaped object (one that looks like a playing piece used in the game of checkers), such as an ingested coin, will appear circular when viewed *en face* but rectangular when viewed in perfect *profile* (Fig. 1.4).

- **Extravasated and extraluminal**: often used in radiology to describe any substance that is outside the vessel.

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![Figure 1.3](http://www.us.elsevierhealth.com/product.jsp?isbn=9780323043175)
(extravasated) or other luminal structure (extraluminal) that originally contained it.
- For example, a ruptured urinary bladder is often said to demonstrate extravasated urine, although the correct term to use here is actually extraluminal.
- Extravasation, according to its original definition, should refer to blood that escapes from the vessel that contained it.
- So, there may be extraluminal contrast seen arising from a ruptured urinary bladder or extraluminal barium seen arising from a ruptured duodenal ulcer or extravasation of contrast arising from a torn renal artery.
- Hemidiaphragm: although anatomically we only have one diaphragm that separates the thorax from the abdomen, radiographically we don’t normally see the diaphragm from one side to the other, so radiologists divide the diaphragm into a right hemidiaphragm and a left hemidiaphragm.
- Horizontal versus vertical x-ray beams: terms that describe orientation of x-ray beams.
- Horizontal and vertical orientation is a very important concept to understand because it will help you in interpreting all kinds of conventional radiographic studies and in understanding their limitations, which may, in turn, prevent you from falling for a diagnostic pitfall.
- An x-ray beam is usually directed either horizontally between the tube and the cassette (as in an erect chest examination in which the patient is standing up) or vertically between the tube and the cassette (as in a supine radiograph of the abdomen with the patient lying on the examining table).
- Horizontal x-ray beams are usually parallel to the floor of the examining room (unless the room was built by do it yourselfers on weekends).
- In conventional radiography, an air-fluid or fat-fluid level will be visible only if the x-ray beam is horizontal, regardless of the position of the patient.
- Therefore, you will never see an air-fluid level no matter what the position of the patient unless the conventional radiographic exposure is made using a horizontal x-ray beam.
- An air fluid or fat fluid level is an interface between two substances of different density in which the lighter substance rises above and forms a straight edge interface with the heavier substance below.
- You usually don’t have to specify whether you want the x-ray beam to be horizontal or vertical when ordering a study; by convention, certain studies are always done using one method or the other (Table 1 2).
- In general, any study with the terms erect, cross-table, or decubitus is always done with a horizontal beam.
- You can see fluid levels (if present) with any of these types of studies, no matter how the patient is positioned.
- You should be aware of the limitations inherent in vertical beam examinations.

Figure 1 4. Coin in the esophagus. Both the frontal (A) and the lateral (B) images of this child’s upper chest demonstrate a radiopaque (white) metallic density in the region of the upper esophagus (white closed arrows). The child swallowed a quarter, which is temporarily lodged in the esophagus just above the aortic arch. Notice how different the coin looks when viewed en face in (A) where it is seen as a circle and in profile (B) where it is seen on end.
Conventions Used in this Book
- **Bold type** is used liberally throughout this text to **highlight important points, and** because this is a book overflowing with important points, **there is much bold type.**
- **Diagnostic pitfalls** (translation: watch your step here or you may fall into a false negative or false positive trap) are signaled by this icon:
- **Really, really important points** (even more important than the important points in **boldface type**) are signaled by this icon:
- The weblink symbol means there is additional instructional material available on the StudentConsult.com website for registered users:

“Take-home” point at the end of chapter are signaled by this icon:
- You may use these points in any location, not only your home.
- Don’t look for them at the end of this chapter because once the word “terminology” was mentioned earlier, you probably skipped ahead to the remainder of the chapters that do have take-home points.

**WebLink**
More information on recognizing the basics of radiology is available to registered users on StudentConsult.com.

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### Table 1-2

<table>
<thead>
<tr>
<th>Examples of Types of Studies</th>
<th>Orientation of Beam</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erect view of the abdomen</td>
<td>Horizontal</td>
<td>Air-fluid levels will be visible; free air will rise to diaphragm</td>
</tr>
<tr>
<td>Left lateral decubitus view of the abdomen</td>
<td>Horizontal</td>
<td>Air-fluid levels will be visible; free air will rise over liver</td>
</tr>
<tr>
<td>Supine abdomen</td>
<td>Vertical</td>
<td>Air-fluid levels will not be visible; free air will rise to undersurface of anterior abdominal wall and may not be visible until large amounts are present</td>
</tr>
<tr>
<td>Erect chest</td>
<td>Horizontal</td>
<td>Pneumothorax, if present, will usually be visible at apex of lung; air-fluid levels (e.g., in cavities) will be visible</td>
</tr>
<tr>
<td>Supine chest</td>
<td>Vertical</td>
<td>Requires much larger pneumothorax to be visible; air-fluid levels will not be visible</td>
</tr>
<tr>
<td>Cross-table lateral examination of the knee</td>
<td>Horizontal</td>
<td>Fat-fluid levels (lipohemarthrosis) if present, will be visible</td>
</tr>
<tr>
<td>Supine examination of the knee</td>
<td>Vertical</td>
<td>Fat-fluid levels will not be visible</td>
</tr>
</tbody>
</table>

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