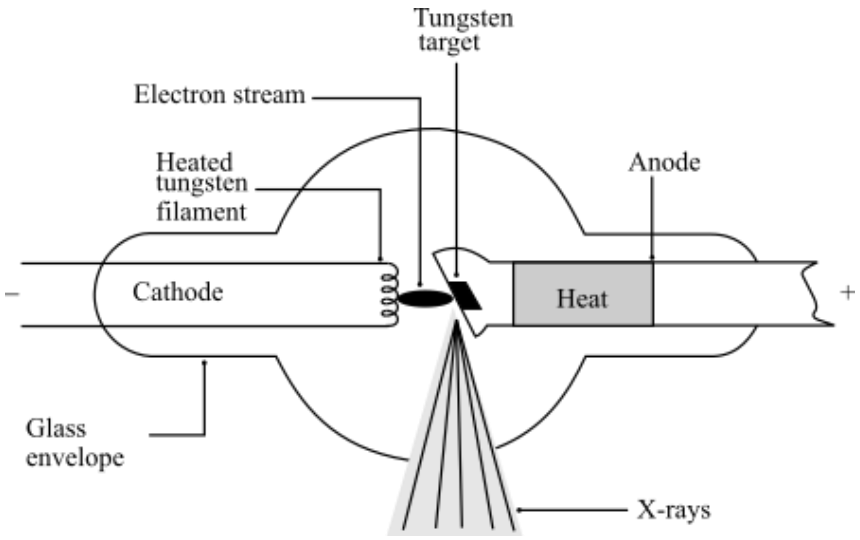
X-Rays

X-Rays or X-radiation is a **form of electromagnetic radiation**. They are powerful waves of electromagnetic energy. Most of them have a wavelength ranging from 0.01 to 10 nanometres, corresponding to frequencies in the range 3×10^{19} Hz to 3×10^{16} Hz and energies in the range 100 eV to 100 keV.



How Do X-Rays work

They are produced when high-velocity electrons collide with the metal plates, thereby giving the energy as the X-Rays and themselves absorbed by the metal plate.

- The X-Ray beam travels through the air and comes in contact with the body tissues, and produces an image on a metal film.
- Soft tissue like organs and skin, cannot absorb the high-energy rays, and the beam passes through them.
- Dense materials inside our bodies, like bones, absorb the radiation.

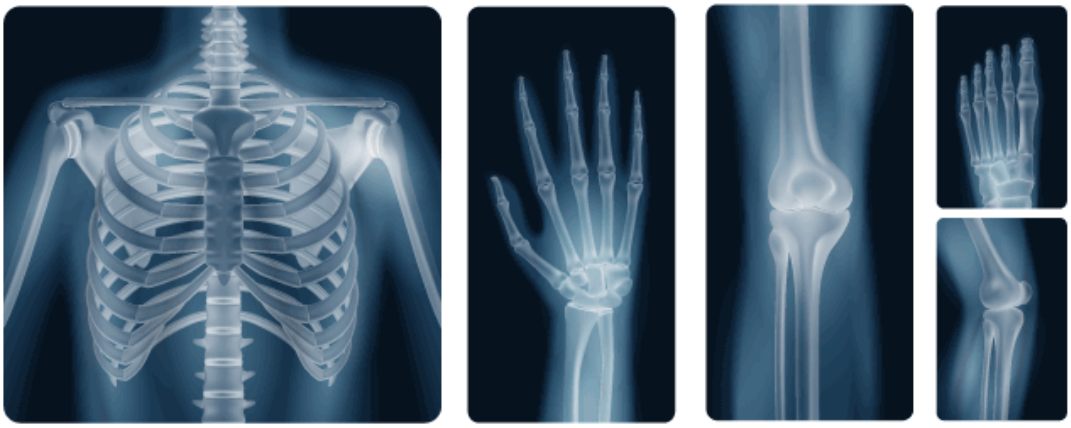
Much like a camera, the X-Ray film develops depending on the areas which were exposed to the X-Rays. White areas show the denser tissues, such as bones that have absorbed the X-Rays whereas black areas on an X-Ray represent areas where the X-Rays have passed through soft tissues.

Properties of X-Rays

The X-Rays properties are given below:

- They have a shorter wavelength of the electromagnetic spectrum.

- Requires high voltage to produce X-Rays.
- They are used to capture the human skeleton defects.
- They travel in a straight line and do not carry an electric charge with them.
- They are capable of travelling in a vacuum.



Types of X-Rays

Medical science recognizes different types of X-Rays. A few important types of X-Rays are given in the points below.

- Standard Computed Tomography
- Kidney, Ureter, and Bladder X-ray
- Teeth and bones X-rays
- Chest X-rays
- Lungs X-rays
- Abdomen X-rays

X-Rays Uses

Since the discovery of X-radiation, they are used in various fields and for various purposes. Some key uses of X-Ray are given below.

- Medical Science
- Security
- Astronomy
- Industry
- Restoration

Medical Use:

They are used for medical purposes to detect the breakage in human bones.

Security:

They are used as a scanner to scan the luggage of passengers in airports, rail terminals, and other places.

Astronomy:

It is emitted by celestial objects and are studied to understand the environment.

Industrial Purpose:

It is widely used to detect the defects in the welds.

Restoration:

They are used to restoring old paintings.

Different Types of X-ray Machines and Their Uses in Medical Imaging

X-ray machines are invaluable tools in the field of medical imaging, enabling healthcare professionals to visualize internal structures and diagnose various medical conditions non-invasively. Over the years, technological advancements have led to different types of X-ray machines, each tailored to specific imaging needs. In this blog, we will explore the various types of X-ray machines commonly used in medical imaging and their particular applications

Conventional Radiography Machines

Conventional radiography machines, or fixed X-ray machines, are the most common type of X-ray equipment found in hospitals and medical facilities. These machines consist of an X-ray tube, flat detector, or film cassette. Conventional radiography is ideal for capturing static two-dimensional images, making it suitable for imaging bones, joints, and the chest. It is widely used in diagnosing fractures, dislocations, lung infections, and assessing bone health.

Fluoroscopy Machines

Fluoroscopy machines are real-time **X-ray** imaging systems allowing continuous visualization of internal structures. These machines use a fluoroscopic screen or digital detector to display the X-ray images in real-time on a monitor. Fluoroscopy is commonly used for guiding interventional procedures, such as catheter insertions, joint injections, and gastrointestinal studies. It is also used during surgeries to assist surgeons in real-time navigation.

Computed Tomography (CT) Scanners

CT scanners are advanced X-ray machines that produce cross-sectional images of the body. These machines use a rotating X-ray tube and a detector array to generate detailed ideas from different angles. CT scans are highly versatile and provide high-resolution images of bones, soft tissues, and organs. They are invaluable in diagnosing complex conditions, such as tumours, vascular diseases, and traumatic injuries, and are essential for planning precise surgical interventions.

Digital Radiography (DR) Machines

Digital radiography machines have replaced conventional film-based X-ray machines with digital detectors. These detectors capture X-ray images directly and produce digital images that can be viewed on a computer screen. DR machines offer several advantages, including faster image acquisition, lower radiation doses, and the ability to enhance and manipulate images for improved diagnostic accuracy. They are used for general radiography and commonly found in medical imaging departments.

C-Arm Machines

C-Arm machines are specialized fluoroscopy systems with a C-shaped arm that can be manoeuvred to different positions. These machines are commonly used in surgical settings and interventional procedures. Their mobility and versatility make them suitable for real-time imaging during orthopaedic surgeries, vascular systems, and pain management interventions.

Dental X-ray Machines

Dental X-ray machines are specifically designed for imaging the teeth and oral structures. They come in various types, including intraoral X-ray machines for capturing images inside the mouth and extraoral X-ray machines for capturing broader views of the dental structures. Dental X-rays aid in diagnosing tooth decay, assessing oral health, and planning dental treatments.

Portable X-ray Machines

Portable X-ray machines are compact and mobile units that can be easily transported to the patient's bedside, emergency rooms, or remote locations. They are handy for imaging critically ill or immobile patients who cannot be moved to conventional X-ray rooms. Portable X-ray machines are commonly used in intensive care units (ICUs), nursing homes, and home healthcare settings.

DENSITY AND OPACITY

A radiograph is an image made up of shadows of different opacities. *Subject density* is the weight per given volume of a body tissue or other object. Bone is more dense than muscle, and muscle is more dense than fat.

The denser an object is, the more it inhibits the passage of radiation. *Radiographic opacity* is a measure of the capacity of a tissue or structure to block x-rays. Where x-rays readily reach the film, the film appears black after processing. If the x-rays are prevented from reaching part of the film, the unaffected area will appear white on the processed film. Between these two extremes, various combinations of light, dark, and gray areas are produced. Radiographic opacity therefore depends on subject density; the greater the subject density, the less radiation reaches the film.

All objects inhibit, to some extent, the passage of radiation. Structures that absorb little of the incident radiation are said to be **radiolucent**. X-rays readily pass through them, and they appear dark on a radiograph. Structures that inhibit the passage of most of the incident radiation are said to be **radiopaque.**

Evaluation of the Abdominal Radiograph

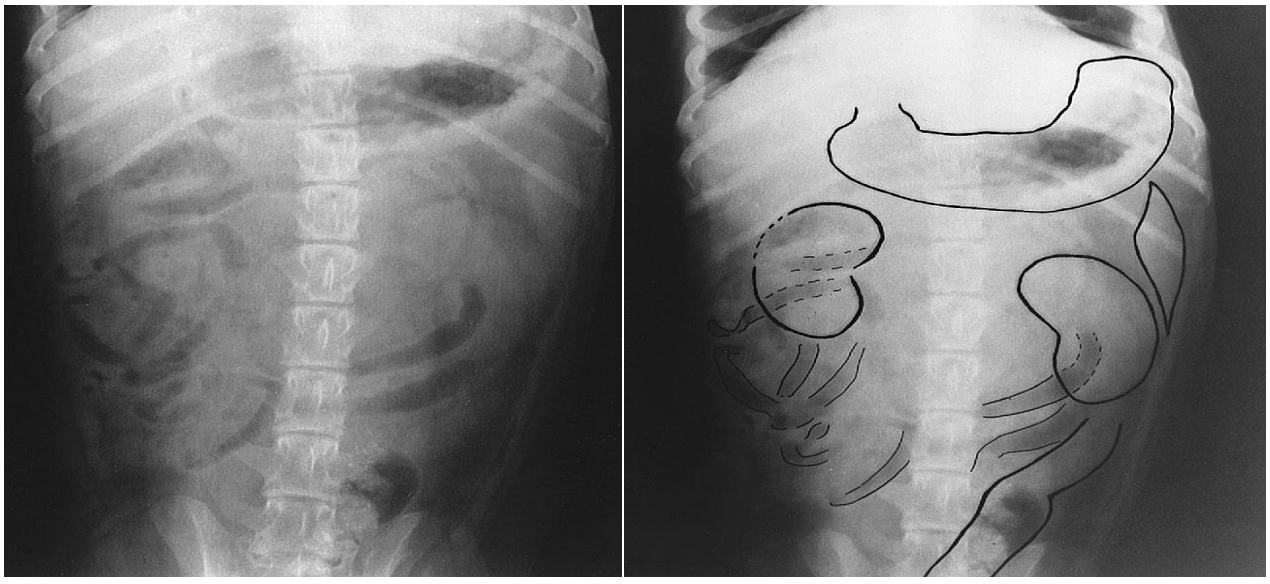
1. A good abdominal radiograph should show the structures in the cranial and caudal abdomen and the abdominal wall.

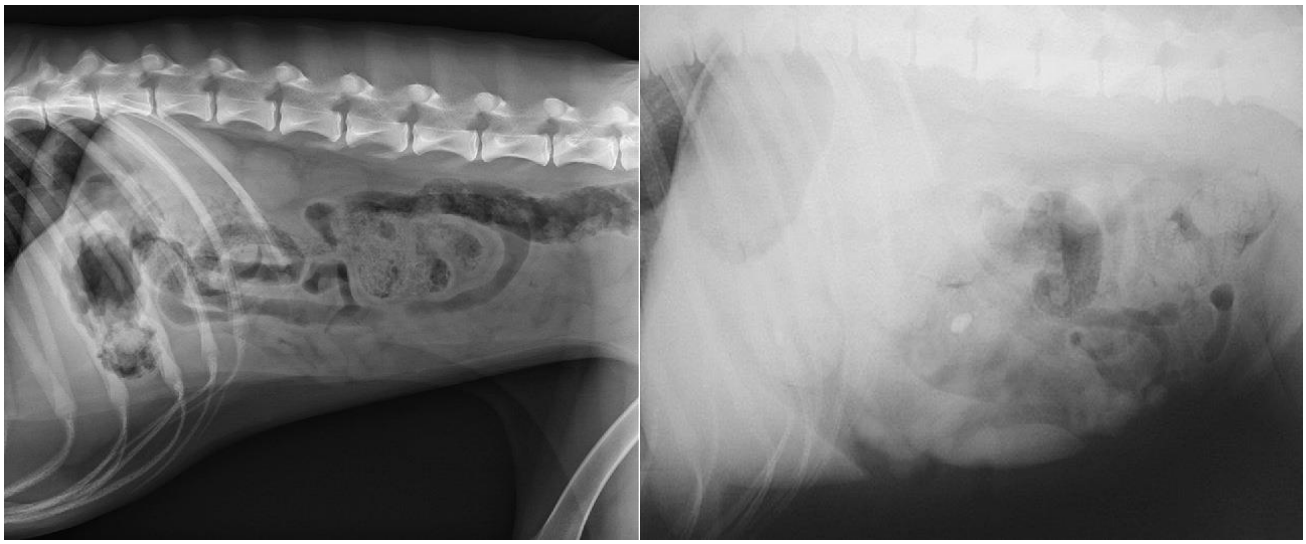
2. There should be good range of contrast so that the various abdominal structures can be clearly distinguished from one another.

3. Falciform and retroperitoneal fat should be identifiable.

4. The bodies of the vertebrae should be clearly outlined and the bone density clearly identifiable.

5. The film should be neither overexposed nor underexposed.

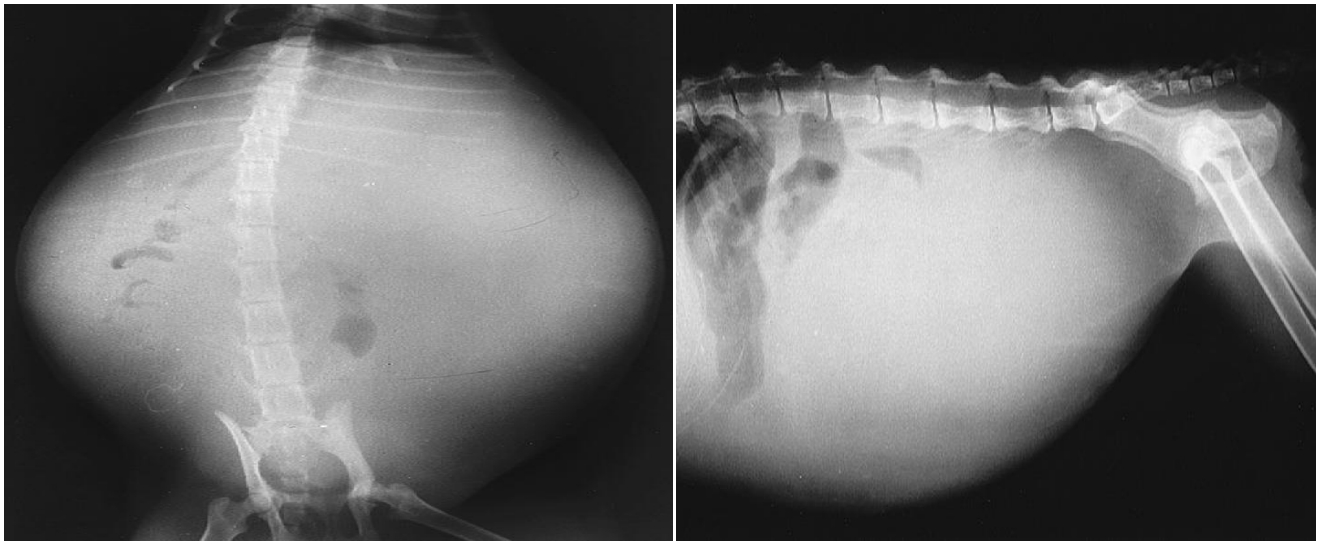




Intraperitoneal Fluid.

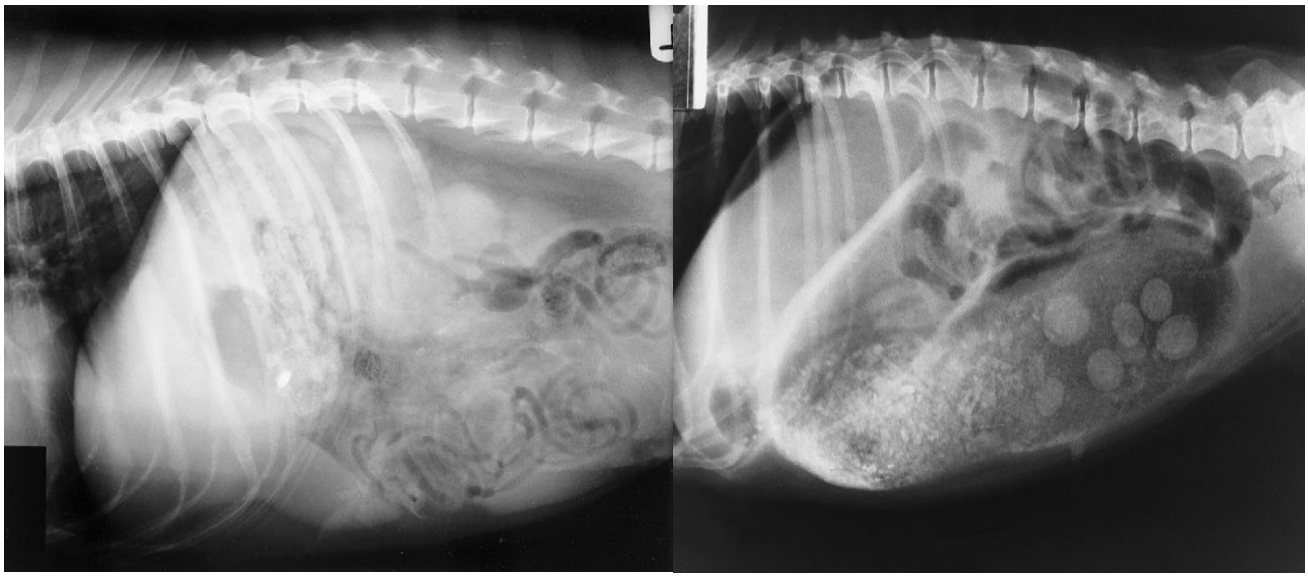
Intraperitoneal fluid may be exudative or transudative in origin, or it may be blood, chyle, urine, or bile. Ascites is defined as an effusion and accumulation of serous fluid in the peritoneal cavity. Common causes of ascites are congestive heart failure, liver abnormalities, renal disease, hypoproteinemia, peritonitis, and abdominal neoplasia.

The term ascites is used colloquially to describe the presence of any fluid in the abdominal cavity.



Free Gas in the Abdomen.

Free gas (air) may be seen in the abdomen for up to 4 weeks after laparotomy. Intraabdominal gas may also be the result of a penetrating wound through the abdominal wall or rupture of a viscus



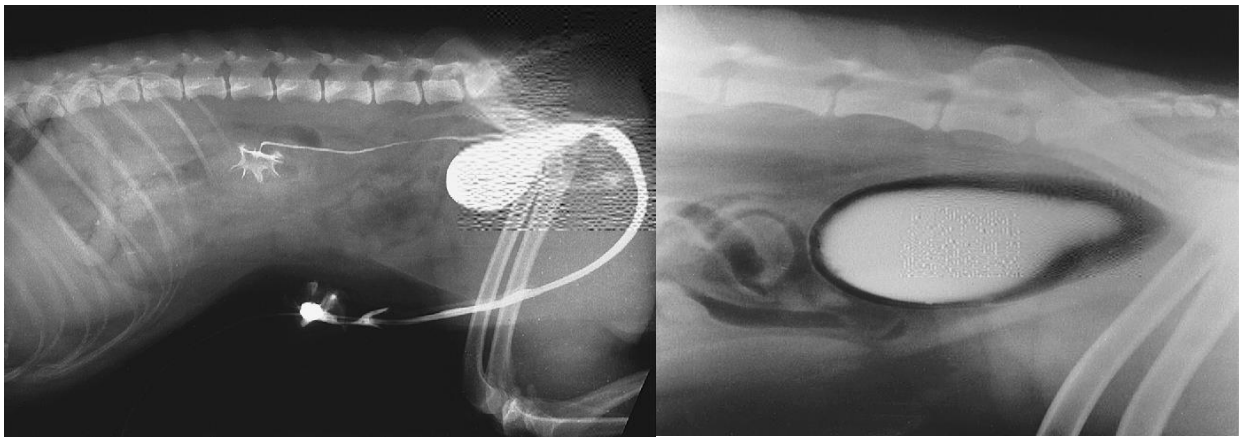
Positive Contrast Cystography.

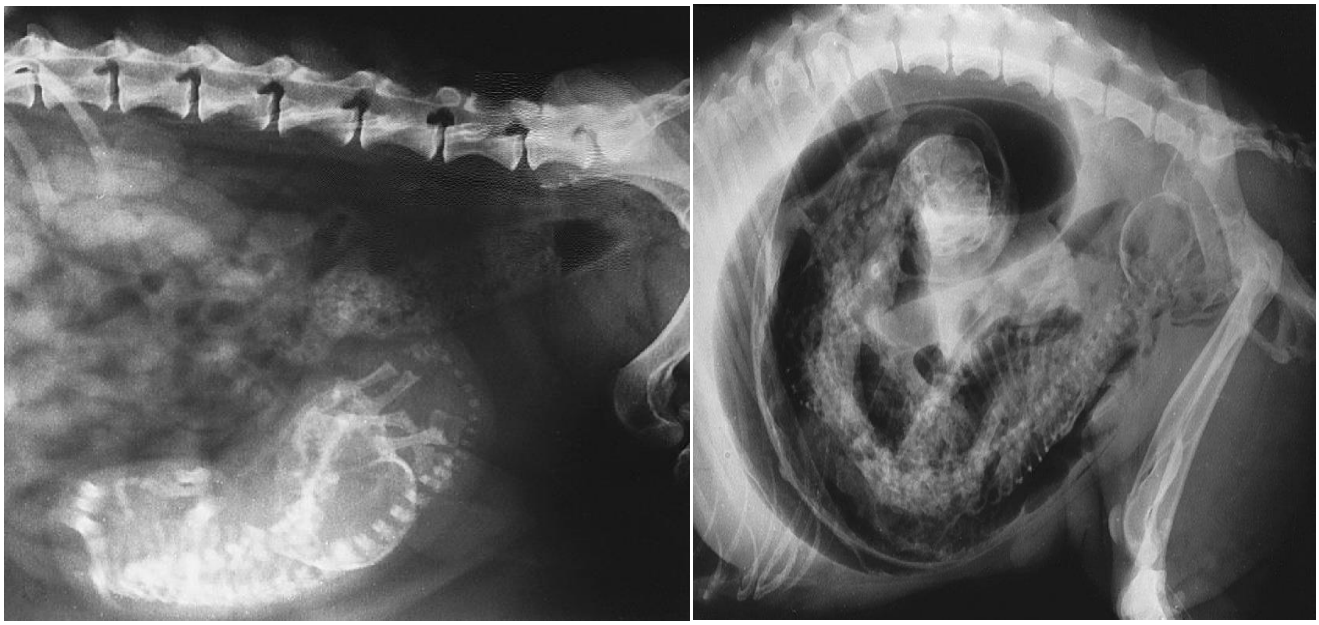
The bladder is evacuated. Any aqueous organic iodide medium recommended for urography is suitable. The contrast medium should be diluted with sterile water or saline to a concentration of 10% to 20% weight/volume of iodine. The contrast medium is injected through a urinary catheter until the bladder is moderately distended. This usually requires approximately 6 to 12 mL/kg body weight of diluted contrast material. Intravenous injection of contrast medium will also outline the bladder as it is being excreted

Double-Contrast Cystography.

A small quantity of 20% weight/volume of water-soluble iodinated contrast medium is first instilled into the evacuated bladder. In dogs the dose of positive contrast is 1 to 5 mL and in cats 0.5 to 1 mL. The animal should be rolled over to coat the bladder mucosa. Lateral and ventrodorsal radiographs are made. The procedure should be carried out with the animal in left

lateral recumbency to reduce the danger of pulmonary embolism, which may be fatal if air is being used. The bladder is then emptied and moderately inflated with gas (air, carbon dioxide, or nitrous oxide), and further radiographs are made. The volume of air is 1 to 5 mL/ kg body weight depending on the size of the dog or cat. Double- contrast cystography gives the most information about the mucosal surface and the thickness of the bladder wall





Fractures

A fracture may be defined as a break or solution in the continuity of a bone. A break in continuity between the metaphysis and the epiphysis is often referred to as an epiphyseal or physeal separation and sometimes as an epiphyseal fracture. Fracture may be the result of trauma, or it may occur because the bone has been weakened by disease (pathologic fracture)