

# Basic Radiographic Procedures

---

## The 'GPT' Method

G. Patrick Thomas, Jr., DC, DACBR

©Copyright 2002

G. Patrick Thomas, Jr., DC, DACBR

PO Box 1000

Blue Springs, MO 64013-1000

[gptdacbr@juno.com](mailto:gptdacbr@juno.com)

# Table of Contents

Chapter 1	Introduction
Chapter 2	Equipment
Chapter 3	The Spine
Chapter 4	The Upper Extremity
Chapter 5	The Lower Extremity
Chapter 6	The Chest and Abdomen
Chapter 7	The GPT Method

# Introduction

## Terminology

- AP, PA, Lateral  
Anterior-Posterior (AP) radiographs are taken with the patient facing the x-ray tube, so that the x-ray beam enters their anterior side, and exits posteriorly.

Posterior-Anterior (PA) films are performed while the patient faces away from the x-ray tube. The x-ray beam goes in their posterior and comes out their anterior.

Lateral radiographs are ones in which the patient stands sideways to the x-ray tube. They can be done with either the patient's left or right side next to the film. If the patient's left side is placed next to the film, it is called a 'left lateral'. 'Right laterals' are done with the patient's right side placed next to the film.

- Oblique  
Oblique radiographs are halfway between AP (or PA) and lateral radiographs. The patient will be rotated about 45 degrees from lateral (or frontal). The nomenclature for oblique films gets very confusing. If the patient's left side is closer to the film than the right, then the view is a 'left oblique'. Furthermore, if the patient is turned so they are obliquely facing the film, that is with their anterior side closer to the film than their posterior, the view is an 'anterior oblique'. So a 'left anterior oblique' projection of the lumbar spine is performed with the patient's left side against the film, and the patient obliquely facing the film. Left anterior oblique is abbreviated 'LPO', and right anterior oblique is abbreviated 'RAO'. Other possibilities include 'LAO' and 'RPO'. Not the easiest system to learn to use, but it is very descriptive. At any rate we are stuck with it by tradition, so get used to it.
- FFD  
The focal-film distance (FFD) describes the distance between the source of the x-ray beam (the focal spot) and the film surface. Also known as source-image distance (SID), this measurement affects magnification, distortion and x-ray beam intensity. To help reduce variability in these factors, we use only two standard focal-film distances, a long one (72") and a short one (40").

- **Tube Tilt**  
Some procedures require that the x-ray tube be angulated either up (cephalad) or down (caudal) a certain number of degrees. An indicator of some type mounted directly to the x-ray tube housing measures tube tilt.
- **Central Ray**  
The central ray is an imaginary x-ray that comes right down the center of the entire x-ray beam. We use the central ray (CR) to point the x-ray beam where we want it to go. Most x-ray views will have a specific anatomical point where the CR should be placed. The collimator of the x-ray machine contains a light bulb that illuminates what anatomy is going to be exposed. The center of that light field is marked by crosshairs, which represent the CR.

## Standards

- **Collimation**  
Restricting the area of the patient irradiated is one of the most effective ways to reduce patient exposure. You should expose as little of the patient as possible, and evidence of use of the collimator should be present on your finished radiographs. There should be at least three edges of collimation on each film.
- **Patient Information**  
Every film must indicate at least three pieces of information:
  1. Patient name or number
  2. Date of examination
  3. Facility where the study was performed
- **Positioning**  
Without positioning markers, it may be impossible to tell on which side of the patient a particular finding is. Markers must be used on every film made.
- **10-Day Rule**  
Everyone knows that it is not advisable to x-ray pregnant women. Unless the mother's life was at risk, few people would x-ray a pregnant patient's lumbar spine. What if a woman does not yet know she is pregnant? The 10-day rule will help prevent exposing an embryo to ionizing radiation. It is physiologically impossible (at least improbable) for a woman to be pregnant during the 10 days following the onset of her menstrual cycle. During this time

period, the chances of accidentally exposing an embryo to radiation are minimal.

- **Gonad Shielding**  
Gonadal shielding should be provided to every patient with 'reproductive potential'. That means when performing examination of the lumbar spine, pelvis and hips of men of any age and pre-menopausal females, gonad shields should be used. An exception to this rule is that gonad shields should not be used if they will obscure the anatomy of interest. For example, it would not be appropriate to use a gonad shield when concerned about a fracture of the sacrum; the shield would block out the sacrum, defeating the purpose of the study.

A word about vasectomies and tubal ligations. These procedures are reversible, and I still use gonad shields for these patients; their lack of 'reproductive potential' may be temporary.

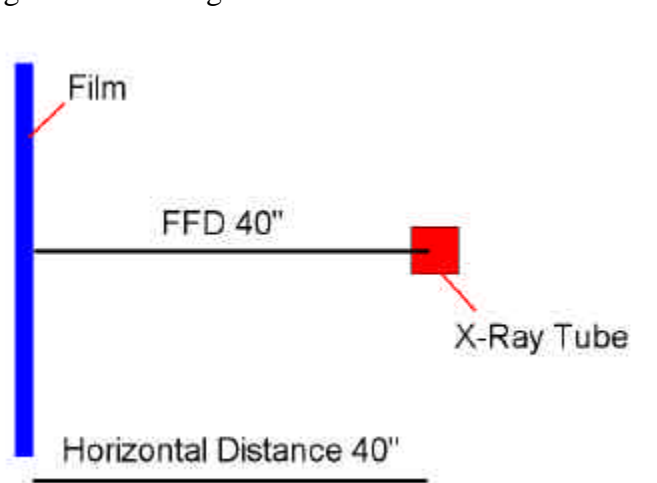
## Tips and Tricks

- **Breathing Instructions**  
The patient's respiratory phase is very important for some views, and really inconsequential for most. Nonetheless, the patient should be given breathing instructions for each view. When performing a lateral projection of the thoracic spine, for example, it is necessary to depress the diaphragm to expose the lower thoracic segments; for this view the patient should be instructed to 'breath in and hold'. The location of the patient's diaphragm has no effect on the outcome of an examination of the wrist, but it may be advisable to instruct the patient to 'breath out and hold'; it seems that it is easier to hold still when one has exhaled. As a rule of thumb, have the patient 'breath in and hold' for any view that should include all 12 thoracic vertebrae. That includes AP and lateral views of the thoracic spine, the AP full spine projection, as well as chest radiographs. The patient should 'breath out and hold' for all other views.

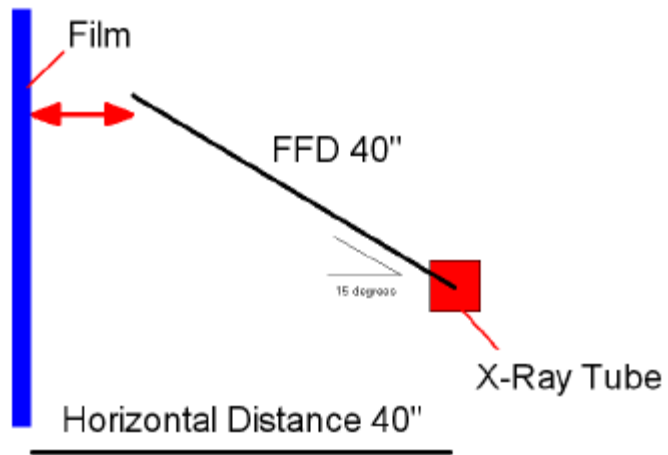
Incidentally, I never tell patient's to 'inhale', 'exhale' or 'expire'. I think that people respond better to language with which they are familiar; I always just say 'breath in' or 'breath out'.

- **FFD**  
The focal-film distance is very important. Using the wrong FFD changes magnification, and leads to over- or underexposure. The usual result is a repeated examination, which at least doubles the

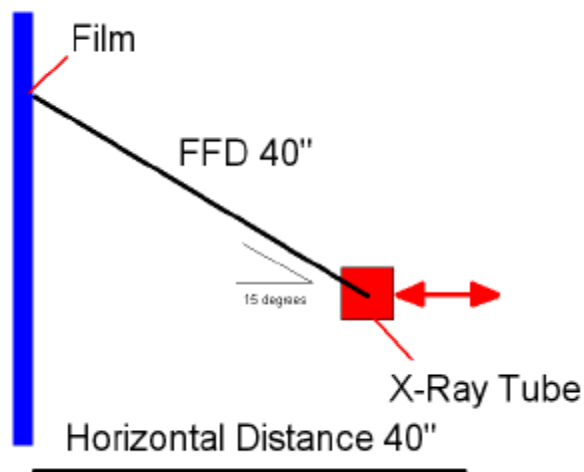
patient's dose. Very few of the views you will commonly use are performed with a FFD of 72"; the rest are all done with a FFD of 40". The 72" views are the AP full spine, neutral lateral cervical, flexion lateral cervical, extension lateral cervical, oblique cervical, PA chest and lateral chest. Everything else is done from 40". It's much easier to memorize that short list of seven views that use a FFD of 72" than to memorize all those that use a 40" FFD. When a particular view incorporates a tube tilt, You must make some adjustments. The AP thoracic view for example, uses no tube tilt and a FFD of 40". With the tube lined up with the 40" mark on the track, the distance from the focal spot of the x-ray tube and the film is the same, 40". If the tube were angulated, however, the distance from the focal spot and the film would increase. The formula for correcting for this situation is as follows: Subtract 1" from the HORIZONTAL distance for each five degrees of tube angulation.



Here with no tube tilt the FFD and HORIZONTAL distances are the same.



Here the tube is angulated and the x-ray beam has to travel farther to meet the film.



Here the HORIZONTAL distance has been reduced to compensate for the tube tilt.

Altering the HORIZONTAL distance maintains the FOCAL-FILM distance. Even though it's only a few inches, remember that small changes in FFD can have a significant effect on beam intensity. Remember the inverse-square law?

# Equipment

## Generators

- **Single-Phase**  
This type of generator is in common usage, and the market is replete with used units. Single-phase generators are economical to purchase, install and use, but produce higher patient doses than more modern high-frequency units.
- **Three-Phase**  
Three phase x-ray generators are expensive to purchase, install and operate. Because of these issues, three-phase units are not frequently employed in private offices.
- **High Frequency**  
Only slightly more expensive than single-phase machines, high frequency units offer the speed and reduced patient dose of three phase generators. This marks the most advanced technology for x-ray production and may soon be the only available option.

## Control Panels

- **Manual Controls**  
Controls labeled 'kVp Major', 'mAs' and the like may seem very cryptic, but with a little practice, this type of control panel is easy to master and offers a great deal of control over the function of the x-ray machine. Typical controls include:
  1. kVp Major
  2. kVp Minor
  3. mA
  4. Timer
  5. Line Compensation
  6. Bucky
- **Anatomical Programming**  
More and more newer x-ray machines offer this feature. All the operator has to do is choose the anatomical area and view, enter the patient's measurement and press the 'expose' button. This ease of use comes at a price however; the operator may have less control over the x-ray machine.



# Cassettes, Screens and Film

- **Rare Earth Screens**  
Rare earth screens are much more efficient than their calcium tungstate predecessors. When exposed to x-radiation, they emit a green light, and therefore must be used with green-sensitive film.
- **Calcium Tungstate Screens**  
These blue-emitting intensifying screens are less efficient than the now standard rare earth screen. They result in comparatively higher patient dose and more motion artifacts with resultant repeat examinations. Their use is not recommended.
- **Radiographic Film**  
Film choice is very important. Heat, humidity and age can ruin film by causing 'fog'. Film must be 'spectrally matched' to the intensifying screens used; green sensitive film can only be used with rare earth screens. I recommend that you use the film the intensifying screen manufacturer suggests.

## Grids

Grids greatly improve the quality of the finished radiograph by filtering out much of the scatter radiation produced during an examination. Things to look for in a grid are a ratio of 10:1 or 12:1, and a frequency of 103 lpi (lines per inch).

# The Spine

## Cervical Region

- **AP Lower Cervical (70 kVp)**

Tube Tilt: 15°cephalad      CR: C4  
FFD: 40”      Instructions: Breath out and hold

- **AP Open Mouth (70 kVp)**

Tube Tilt: 5°cephalad      CR: Through the uvula  
FFD: 40”      Instructions: Breath out and hold

- **Neutral Lateral (70 kVp)**

Tube Tilt: none      CR: C4  
FFD: 72”      Instructions: Breath out and hold

Notes: Heavy weights may be held by the patient to help lower the shoulders

- **Flexion and Extension Lateral (70 kVp)**

Tube Tilt: none      CR: C4  
FFD: 72”      Instructions: Breath out and hold

Notes: Heavy weights may be held by the patient to help lower the shoulders

- **Oblique Projections (70 kVp)**

Tube Tilt: 15°cephalad      CR: C4  
FFD: 72”      Instructions: Breath out and hold

## Thoracic Region

- **AP (80 kVp)**

Tube Tilt: None      CR: T6  
FFD: 40”      Instructions: Breath in and hold

Notes: A filter placed over the upper thoracic spine helps produce a more uniform density on the finished radiograph

- **Lateral (70 kVp)**

Tube Tilt: None      CR: T6  
FFD: 40”      Instructions: Breath in and hold

# Ribs

- **AP Hemithorax (70-80kVp)**  
Tube Tilt: None                      CR: Area of concern  
FFD: 40”                                Instructions: See Notes below
- **PA Hemithorax (70-80kVp)**  
Tube Tilt: None                      CR: Area of concern  
FFD: 40”                                Instructions: See Notes below
- **Anterior Oblique (70-80kVp)**  
Tube Tilt: None                      CR: Area of concern  
FFD: 40”                                Instructions: See Notes below
- **Posterior Oblique (70-80kVp)**  
Tube Tilt: None                      CR: Area of concern  
FFD: 40”                                Instructions: See Notes below

Notes: A ‘rib series’ should consist of a frontal view, a posterior oblique view and an anterior oblique view.

If the area of concern is at the anterior chest wall, then the frontal view will be done as a PA, to place the area of concern closest to the film. The AP view will be performed for patients with posterior chest wall pain.

If the area of concern is on the patient’s right side, then both the anterior and posterior oblique views will be performed with the patient’s right side closest to the film (RAO/RPO). Left-sided obliques (LAO/LPO) are used for patient with left-sided pain.

Example 1: If your patient has right-sided anterior rib pain, the study would consist of the following views:

- PA Hemithorax
- Right Anterior Oblique
- Right Posterior Oblique

Example Two: If you patient had left-sided posterior chest pain, the study would consist of the following views:

- AP Hemithorax
- Left Anterior Oblique
- Left Posterior Oblique

Seventy kVp should be used if the area of interest is one of the ribs above the diaphragm (AD), numbers 1-9. Ribs 10-12 (below the diaphragm, or BD) are best examined using 80 kVp.

The patient should be instructed to 'breath in and hold' when examining ribs 1-9, and 'breath out and hold' when examining ribs 10-12.

## Lumbar Region

- **AP (80 kVp)**  
 Tube Tilt: None CR: L3 (1" above the iliac crest)  
 FFD: 40" Instructions: Breath out and hold
- **Lateral (80 kVp)**  
 Tube Tilt: None CR: L3 (1" above the iliac crest)  
 FFD: 40" Instructions: Breath out and hold
- **Oblique Projections (80 kVp)**  
 Tube Tilt: None CR: 1" anterior to the L3 SP  
 FFD: 40" Instructions: Breath out and hold
- **PA Lumbosacral Spot View (80 kVp)**  
 Tube Tilt: 30° caudal CR: L5 SP  
 FFD: 40" Instructions: Breath out and hold

## Sacrum

- **AP (80 kVp)**  
 Tube Tilt: 15° cephalad CR: halfway between the symphysis  
 pubis  
 FFD: 40" and the ASIS, in the midline  
 Instructions: Breath out and hold
- **Lateral (80 kVp)**  
 Tube Tilt: None CR: 2" anterior to S2  
 FFD: 40" Instructions: Breath out and hold

# Sacroiliac Joints

- **Posterior Oblique Projections (80 kVp)**

Tube Tilt: None

CR: 1" medial to the ASIS

FFD: 40"

Instructions: Breath out and hold

Notes: The side of interest is elevated

# Coccyx

- **AP (80 kVp)**

Tube Tilt: 10° caudal

CR: 1" superior to the symphysis pubis

FFD: 40"

Instructions: Breath out and hold

- **Lateral (80 kVp)**

Tube Tilt: None

CR: 2" anterior to the sacrococcygeal joint

FFD: 40"

Instructions: Breath out and hold

# Pelvis

- **AP (80 kVp)**

Tube Tilt: None

CR: halfway between the symphysis pubis and the ASIS, in the midline

FFD: 40"

Instructions: Breath out and hold

Notes: There is no lateral view of the pelvis

# Full Spine

- **AP (80 kVp)**

Tube Tilt: None

CR: through the center of the film  
(See Notes below)

FFD: 72"

Instructions: Breath in and hold

Notes: Adjust the height of the bucky so that the top of the film is at the height of the patient's nose. Next, line the CR up with the center of the film.

Some type of compensating filter will need to be placed over the upper portion of the exposure field

# The Upper Extremity

## Glenohumeral Joint

- **AP with Internal Rotation (70 kVp)**  
Tube Tilt: None CR: Through the coracoid process  
FFD: 40" Instructions: Breath out and hold
- **AP with External Rotation (70 kVp)**  
Tube Tilt: None CR: Through the coracoid process  
FFD: 40" Instructions: Breath out and hold
- **AP with Abduction-“Baby Arm” (70 kVp)**  
Tube Tilt: None CR: Through the coracoid process  
FFD: 40" Instructions: Breath out and hold

## Acromioclavicular Joint

- **AP With and Without Stress (70 kVp)**  
Tube Tilt: 5° cephalad CR: 1" inferior to the A/C joint  
FFD: 40" Instructions: Breath out and hold

Notes: This study is comprised of four views: a non-stressed view of both the left and right A/C joint, as well as stressed views of each articulation. While the absolute width of each joint is important, differences between the left and right may be more significant.

## Clavicle

- **AP (70 kVp)**  
Tube Tilt: 15° cephalad CR: 1" inferior to the midpoint of the clavicle  
FFD: 40" Instructions: Breath out and hold
- **PA (70 kVp)**  
Tube Tilt: 10° caudal CR: 1" inferior to the midpoint of the clavicle  
FFD: 40" Instructions: Breath out and hold

# Elbow

- **AP (60 kVp)**  
Tube Tilt: None CR: 1" distal to the elbow joint  
FFD: 40" Instructions: Breath out and hold
- **Lateral (60 kVp)**  
Tube Tilt: None CR: 1" distal to the lateral  
epicondyle  
FFD: 40" Instructions: Breath out and hold
- **Medial Oblique (60 kVp)**  
Tube Tilt: None CR: 1" distal to the elbow joint  
FFD: 40" Instructions: Breath out and hold
- **Tangential-Jones (60 kVp)**  
Tube Tilt: None CR: 1" distal to the olecranon  
process  
FFD: 40" Instructions: Breath out and hold

# Wrist

- **PA (55 kVp)**  
Tube Tilt: None CR: Midcarpal  
FFD: 40" Instructions: Breath out and hold

Notes: The patient's fingers should be curled under into a loose fist.

- **PA with Ulnar Deviation (55 kVp)**  
Tube Tilt: None CR: Midcarpal  
FFD: 40" Instructions: Breath out and hold

Notes: The patient's wrist should be medially (ulnar side) flexed.

- **Medial Oblique (55 kVp)**  
Tube Tilt: None CR: Midcarpal  
FFD: 40" Instructions: Breath out and hold  
Notes: The lateral side (thumb side) of the hand should be elevated an inch or so.

- **Lateral (55 kVp)**  
Tube Tilt: None CR: Midcarpal/Snuffbox  
FFD: 40" Instructions: Breath out and hold





# The Lower Extremity

## Hip

- **AP (80 kVp)**  
Tube Tilt: None CR: 1" lateral to the midpoint of the inguinal ligament  
FFD: 40" Instructions: Breath out and hold

Notes: The patient's foot should be internally rotated 10-15°

- **Frogleg (80 kVp)**  
Tube Tilt: None CR: 1" lateral to the midpoint of the inguinal ligament  
FFD: 40" Instructions: Breath out and hold

Notes: The patient's legs should be crossed into a figure-four.

## Knee

- **AP (60 kVp)**  
Tube Tilt: 5° cephalad CR: Inferior pole of the patella  
FFD: 40" Instructions: Breath out and hold

- **Lateral (60 kVp)**  
Tube Tilt: 10° cephalad CR: Center of joint  
FFD: 40" Instructions: Breath out and hold

Notes: The knee should be flexed 45°.

- **Intercondylar (60 kVp)**  
Tube Tilt: 45° caudal CR: Center of the popliteal fossa  
FFD: 40" Instructions: Breath out and hold

Notes: The knee should be flexed 45°, supported with a pillow or other object.

- **Tangential (60 kVp)**  
Tube Tilt: 10° cephalad CR: Inferior pole of the patella  
FFD: 40" Instructions: Breath out and hold

Notes: The knee should be maximally flexed.



# Calcaneus

- **Axial (55kVp)**  
Tube Tilt: 45° cephalad  
FFD: 40"  
CR: 2" up from the film  
Instructions: Breath out and hold
- **Lateral (55kVp)**  
Tube Tilt: None  
FFD: 40"  
CR: 1" inferior from the medial malleolus  
Instructions: Breath out and hold

# The Chest and Abdomen

## Chest

- **PA (100 kVp)**

Tube Tilt: None

CR: Through the center of the film  
(See Notes below).

FFD: 72"

Instructions: Breath in and hold

Notes: Adjust the height of the bucky so that the top of the film is 2 inches above the patient's shoulders. Direct the CR through the center of the film.

- **Lateral-Left (100 kVp)**

Tube Tilt: None

CR: Through the center of the film  
(See Notes below).

FFD: 72"

Instructions: Breath in and hold

Notes: Adjust the height of the bucky so that the top of the film is 2 inches above the patient's shoulders. Direct the CR through the center of the film.

## Abdomen

- **AP (70 or 100 kVp)**

Tube Tilt: None

CR: At the top of the iliac crests

FFD: 40"

Instructions: Breath out and hold

Notes: 70 kVp should be used when searching for a calcium-based pathology such as a renal calculus. Use 100 kVp when soft tissue pathology is suspected.

# The 'GPT' Method

Years of teaching radiographic positioning, as well as practical experience have taught me that one needs to have a method when performing complicated tasks such as performing radiographic examinations. The method listed below will improve your speed and competency when performing examinations.

There are a lot of small details that must be addressed when performing radiographic studies. Most of the time an error in one will lead to errors in the others. I recommend a particular order in which to do things to help avoid this common problem.

## 1. Tube Tilt

Always set the tube tilt before anything else. If this is wrong, nothing else will work out right.

## 2. FFD

Once the tube tilt is set, you can select the proper FFD. Remember to adjust the FFD for the tube tilt, if applicable.

## 3. Central Ray

Now you're ready to adjust the tube height and/or the patient to get the CR to go where it is supposed to go.

## 4. Film

Lastly, line up the film with the CR.

Here's a little mnemonic to help you remember  
**T-F-C-F**

Before you actually expose the patient, you should make sure that the following have been addressed:

- Positioning marker
- Patient measurement
- Filters
- Gonad shielding
- Patient instructions

# Easy Ways To Remember Difficult Things

## Breathing Instructions

The following views require that the patient 'breath in and hold':

- AP Full Spine
- Thoracic, AP and lateral
- Chest, PA and lateral

Tell your patient to 'breath out and hold' for everything else. When in doubt, have them breath out.

## Focal Film Distances

The following views are done with a FFD of 72":

- AP Full Spine
- Chest, PA and lateral
- Cervical, Neutral, flexion, extension and obliques.

Every other view is performed with a FFD of 40". When in doubt, use 40".

## Measuring Your Patient

When in doubt, measure the thickest part of the anatomy to be radiographed. For example, when examining the knee, measure the thickness of the thigh just above the patella; by doing this you ensure that there will be no underexposed areas on the finished film.

# Standard Series

## Cervical

### 3 View

AP Lower Cervical  
AP Open Mouth  
Neutral Lateral Cervical

### 5 View

AP Lower Cervical  
AP Open Mouth  
Neutral Lateral Cervical

### **Plus**

Flexion Lateral Cervical  
Extension Lateral Cervical

### **Or**

Right Posterior Oblique  
Left Posterior Oblique

### 7 view

AP Lower Cervical  
AP Open Mouth  
Neutral Lateral Cervical  
Flexion Lateral Cervical  
Extension Lateral Cervical  
Right Posterior Oblique  
Left Posterior Oblique

## Thoracic

AP  
Lateral



# Lumbar

## Two View

AP  
Lateral

## Three View

AP  
Lateral  
PA Lumbosacral Spot View

## Four View

AP  
Lateral  
Right Anterior Oblique  
Left Anterior Oblique

## Five View

AP  
Lateral  
PA Lumbosacral Spot View  
Right Anterior Oblique  
Left Anterior Oblique

# Sacrum

AP  
Lateral

# Sacroiliac Joints

Right Posterior Oblique  
Left Posterior Oblique

# Coccyx

AP  
Lateral

# Pelvis

AP

# AP Full Spine With Opposing Views

AP Full Spine  
Neutral lateral Cervical  
Lateral Thoracic  
Lateral Lumbar  
PA Lumbosacral Spot View

# Ribs

Frontal Hemithorax  
Anterior Oblique  
Posterior Oblique

# Shoulder

AP with Internal Rotation  
AP With External Rotation  
AP With Abduction (Baby-Arm)

# A/C Joints

AP Non-Stressed Left A/C joint  
AP Non-Stressed Right A/C joint  
AP Stressed Left A/C joint  
AP Stressed Right A/C joint

# Clavicle

AP  
PA

# Elbow

AP  
Medial Oblique  
Lateral  
Tangential

# Wrist

PA  
Medial Oblique  
Lateral  
PA With Ulnar Deviation

# Hand

PA  
Medial Oblique  
Lateral

# Hip

AP  
Frog Leg

# Knee

AP  
Lateral  
Intercondylar  
Tangential

# Ankle

AP  
Medial Oblique  
Lateral

# Foot

AP (Dorso-Plantar)  
Medial Oblique  
Lateral

# Calcaneus

Axial  
Lateral

# Chest

PA  
Left Lateral

# Abdomen

AP (KUB)

## References

- Yochum TR, Rowe LJ: *Essentials of Skeletal Radiology*, Baltimore, Williams and Wilkins, 1996

©Copyright 2002

G. Patrick Thomas, Jr., DC, DACBR

PO Box 1000

Blue Springs, MO 64013-1000

[gptdacbr@juno.com](mailto:gptdacbr@juno.com)