Chapter 10

Formulating X-Ray Techniques

Learning Objectives

- Read and use an x-ray technique chart
- List methods for obtaining and/or creating an x-ray technique chart
- Accurately measure a body part using an x-ray caliper
- Compare fixed kilovolts peak (kVp) technique charts with variable kVp technique charts and state which is preferable

Learning Objectives (Cont’d)

- Explain what is meant by optimum kVp and how this value is determined
- Select an appropriate milliamperage station for a given set of circumstances
- Take appropriate steps when the technique chart fails to provide an appropriate exposure

Learning Objectives (Cont’d)

- Calculate exposure adjustments for changes in patient/part size
- Determine the technique change required when radiographs are too dark or too light
- Suggest appropriate technique changes for increasing or decreasing the scale of contrast
- Calculate technique changes for variation in source–image receptor distance

Technique Charts

- Contain information on:
  - Type of examination and projection
  - Patient measurement in cm
  - Digital exposure index
  - SID
  - kVp
  - mA
  - Exposure time
  - Grid usage

Technique Charts (Cont’d)

- Used to select exposure factors
- Each chart is unique to a particular x-ray machine
- Technique charts may be generated by
  - Film manufacturers
  - Technologists

Typical Film/Screen Imaging Chart

Manual Timed Exposures Guideline
Medium-High Frequency equipment
12:1 table Bucky; 10:1 vertical Bucky
400/100 film/screen imaging

Typical output
60 kVp 2.5-3.0 mR/mAS
80 kVp 5.0-6.0 mR/mAS
110 kVp 10-12 mR/mAS

CHEST PA & Lat 8:1 - 10:1 Grid - *typical high frequency/400 speed imaging*

CM 72" SID	16	20	24	28	32	36	40
kVp	90	110	110	110	110	110	110
mAS	1.5	1.5	3.0	6.0	12	24	48
NON GRID	76 kVp 0.75 mAS	80 kVp Same mAS					

EXTREMITES *typical high-frequency 100 speed/400 speed - tabletop*

CM typical anatomy 40" SID	1-2 digits	3-4 PA hand, PA wrist, distal foot	5-7 Lat wrist, forearm, prox foot, lat ankle	8-9 elbow, AP ankle, lower leg	10-11 humerus, knee
kVp	56	60	60	60	60
▶ mAS 100 speed	1.5	2.0	3.0	4.0-5.0	6.0
▶ mAS 400 speed	52 kVp 1.0 mAS	56 kVp 1.0 mAS	60 kV @ 1.0	60 kV @ 1.5	60 kV @ 2.0

SHOULDER/KNEE *typical high-frequency 400 speed - 10/12:1 Bucky/grid*

CM 40" SID	9-10	11-12	13-14	15-16	
kVp	80	80	80	80	
mAS	1.5	2.0	3.0	4.0	
Axial shoulder	Clavicle with 25°tilt	Trans thoracic	Scapular Y view	Tangential knee	Tunnel knee
no grid 70-72 kVp 1.0 mAS	mutiply AP mAS by 1.5	measure chest and humerus 80 kVp 36 cm 80mAS 40 cm 160mAS	80 kVp 6-8 mAS	no grid 80 kVp 60" SID 5 mAS 40" SID 2.5	with Bucky about same as AP no grid multiply AP mAS by 0.2

Adjusting an Existing Technique Chart

- When the technique chart is not producing images with appropriate contrast and density:
  - Check x-ray machine calibration and digital processor systems
  - Ensure that all personnel are using the chart properly
  - Make changes to the technique chart only after ensuring all factors that could affect the techniques have been evaluated

Patient Measurement

- Use of a technique chart requires accurate patient measurement
  - Sandwich the body part between the lower and upper caliper jaws
  - Place the jaws directly against the body part
  - Do not compress the body part with the calipers
  - Measure the body part in the position that the exposure will be taken

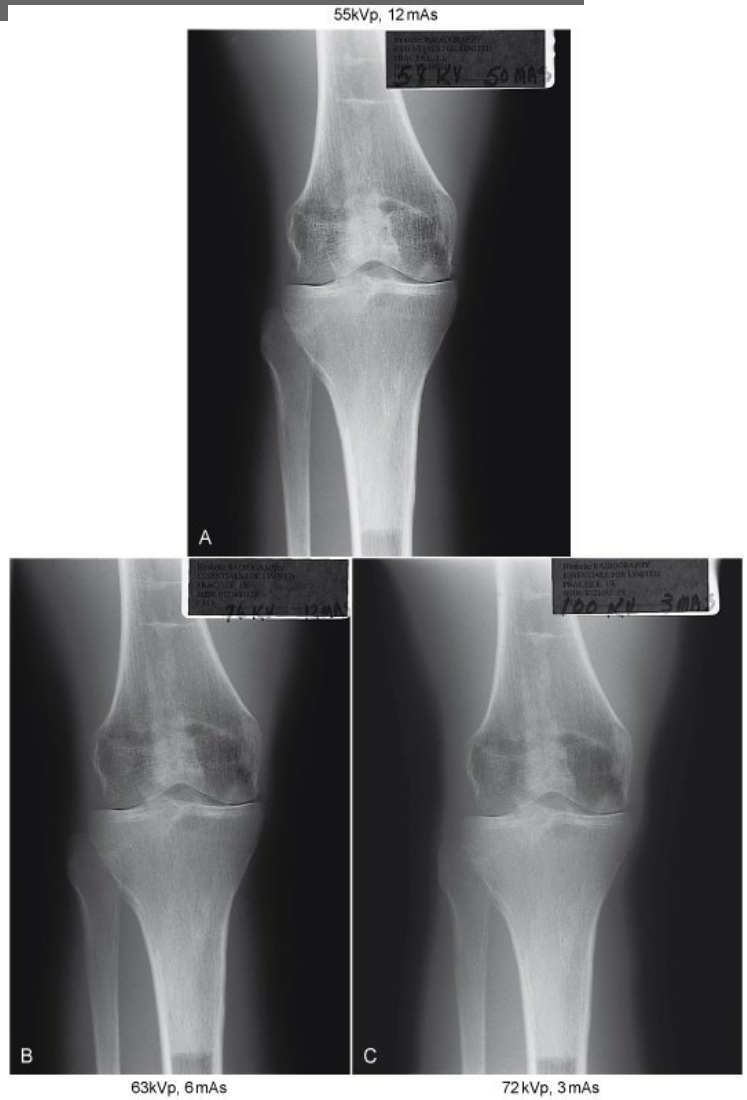
Ballinger PW, Frank ED: *Merrill's atlas of radiographic positions and radiologic procedures*, ed 10, St Louis, 2003, Mosby.

Fixed and Variable kVp Technique Charts

- Fixed kVp
  - Optimum kVp for each projection is determined and remains constant
  - mAs is adjusted according to patient thickness
  - Results in greater exposure latitude (a wider range of densitites are shown on image)
- Variable kVp
  - mAs for each body part remains the same
  - Adjustments of 2 to 3 kVp for each cm change in patient size
  - Results in higher image contrast which provides greater visibility of detail

Optimum kVp

- Refers to the kVp that produces appropriate image contrast
- Determined by taking a series of phantom images in which kVp and mAs are varied
  - Adjust kVp using the 15% rule
  - When kVp is decreased by 15%, double the mAs to maintain density



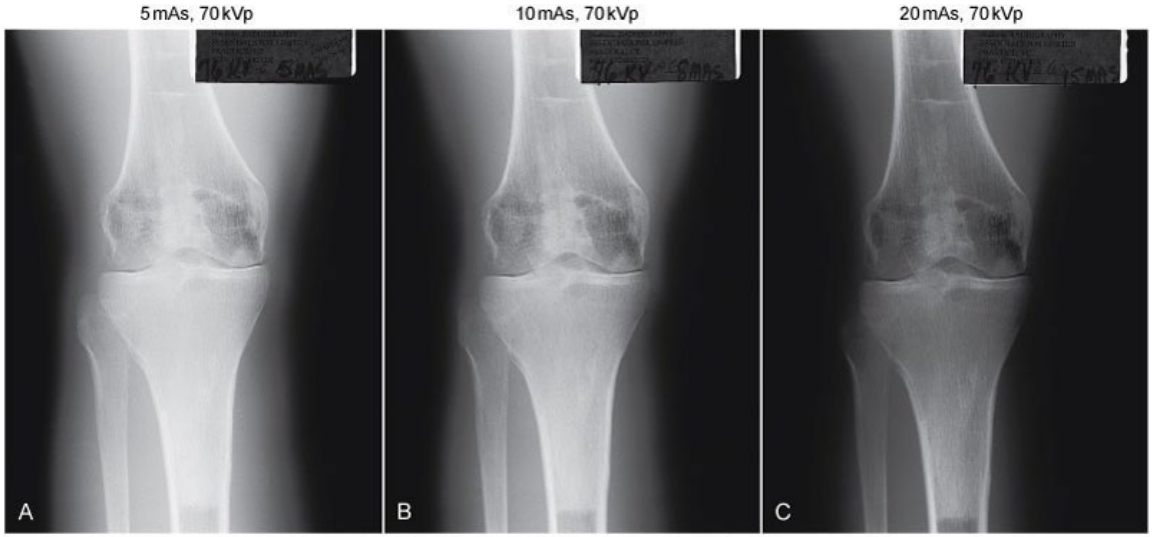
Milliamperage Selection

- Different mA and time combinations may produce the same mAs
  - Example: 300 mA $\times$ 0.1 sec = 30 mAs

    150 mA $\times$ 0.2 sec = 30 mAs
- Choice of mA depends on
  - Tube rating
  - Focal spot size
  - Exposure time
  - Available mA settings

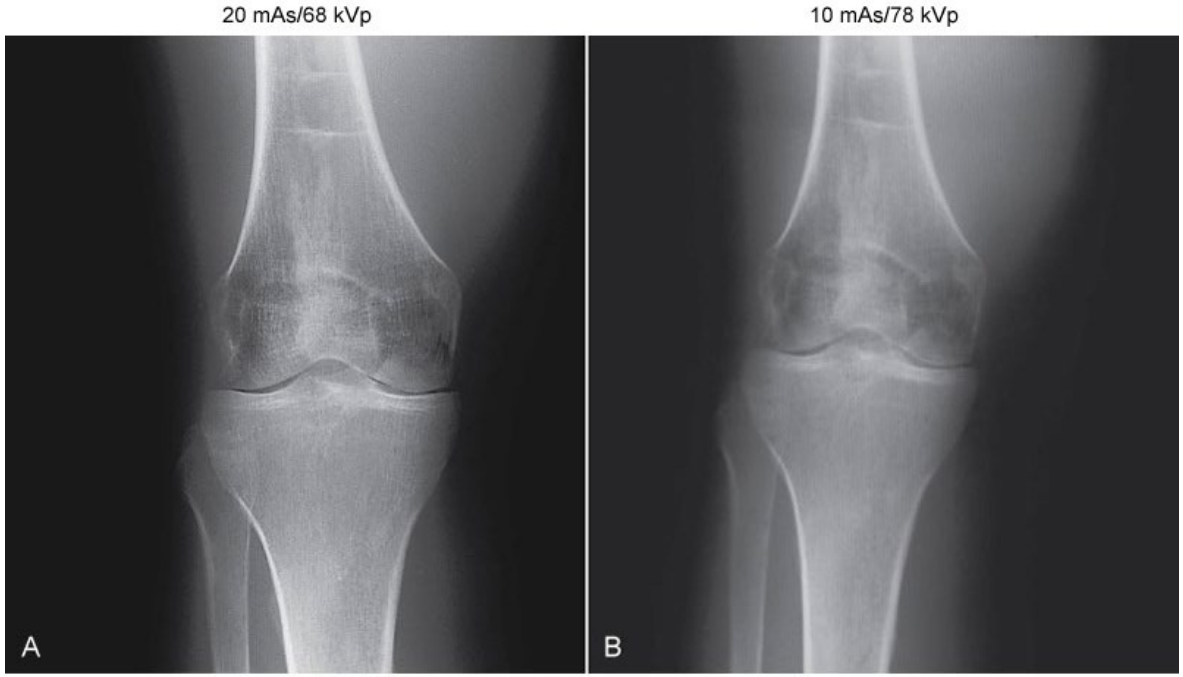
Technique Adjustment

- Patient Size
  - Increase mAs 30% for each 2-cm increase; Decrease mAs 20% for each 2-cm decrease
  - Change of 2 kVp/cm below 85 kVp; above 85 kVp change of 3 kVp/cm
- Insufficient and Excessive Density
  - Increase mAs 100% when density is insufficient
  - Decrease mAs 50% when density is excessive



Technique Adjustment (Cont'd)

- Contrast Too Low
  - Decrease kVp by 15% and increase mAs by 100% to maintain density
- Contrast Too High
  - Increase kVp by 15% and decrease mAs by 50% to maintain density



Technique Adjustment (Cont'd)

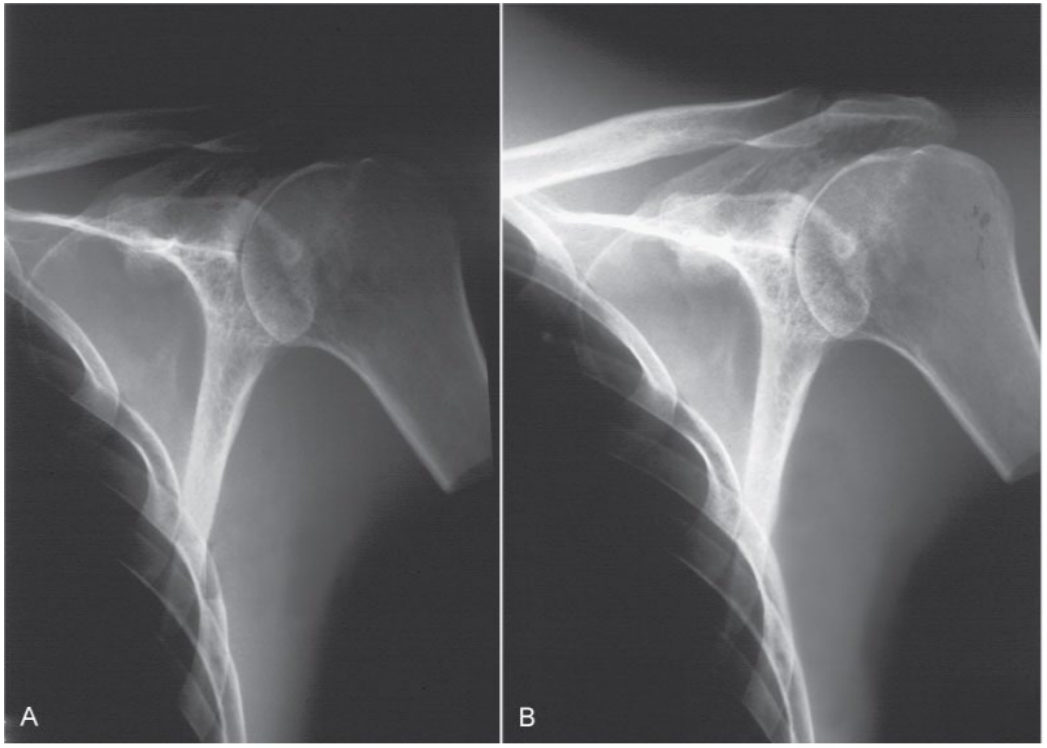
- Variations in SID affect density
- Use formula to
  - Increase mAs when SID is increased
  - Decrease mAs when SID is decreased

$$\frac{mAs_1}{mAs_2} = \frac{(SID_1)^2}{(SID_2)^2}$$

mAs_1 = Original mAs
mAs_2 = New mAs
SID_1 = Original distance
SID_2 = New distance

Compensating Filters

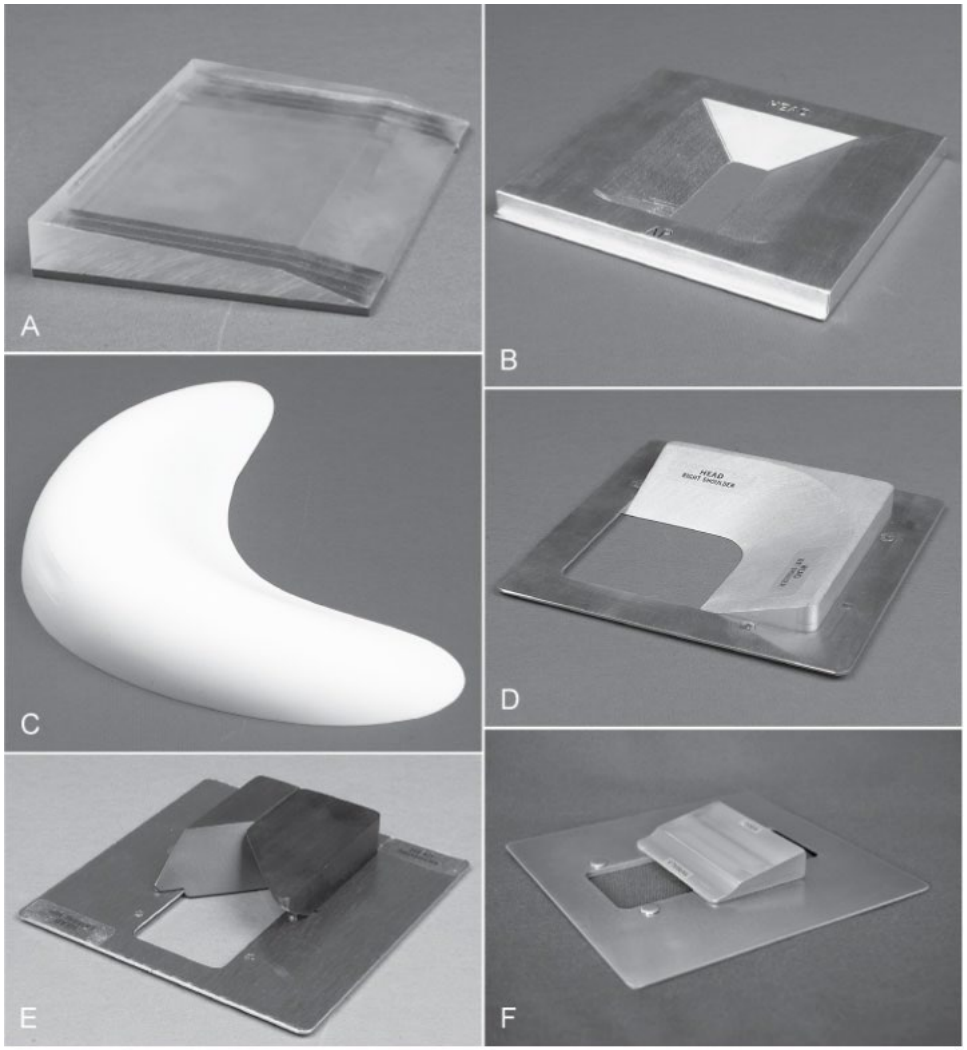
- Placed between the x-ray tube and patient to achieve consistent radiographic density for body parts that vary in thickness



Ballinger PW, Frank ED: *Merrill's atlas of radiographic positions and radiologic procedures*, ed 10, St Louis, 2003, Mosby. Ferlic Filter Company, LLC, White Bear Lake, Minn.

Compensating Filters (Cont’ d)

- Types of filters
  - Wedge
  - Trough
  - Boomerang
  - Ferlic for shoulder
  - Ferlic for cervicothoracic region
  - Ferlic for foot



Ballinger PW, Frank ED: *Merrill's atlas of radiographic positions and radiologic procedures*, ed 10, St Louis, 2003, Mosby.

Summary

- Technique charts provide sets of exposure factors according to body part and patient size
- Make changes to the technique chart only after ensuring all factors that could affect the techniques have been evaluated
- Measurements needed to create technique charts are obtained using calipers

Summary (Cont’d)

- Technique charts are either fixed or variable kVp
- For any type of technique chart, the optimum kVp or the kVp that will produce appropriate image contrast must be determined
- mA selection depends on tube rating, focal spot size, exposure time, and available mA settings

Summary (Cont’d)

- Exposure time affects density and can be calculated by dividing the mA by the mAs
- Increase mAs when patient size increases or the density is insufficient
- Decrease mAs when patient size decreases or the density is excessive
- Decrease kVp to obtain a shorter scale or higher contrast

Summary (Cont’d)

- Increase kVp to obtain a lower or longer scale of contrast
- To maintain density when SID is increased, increase mAs
- Compensating filters are placed between the x-ray tube and patient to achieve consistent radiographic density for body parts that vary in thickness