Technique Still Matters

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Objectives

- The goal of good technique is to penetrate the anatomy correctly and deliver the appropriate quantity of radiation to the image receptor.
- The characteristics of the equipment that determine the technique to be used.
- Image quality problems that occur when the wrong kVp and mAs are used.
- Make a technique chart.

Before you develop techniques

- The x-ray producing equipment has been tested by a qualified expert.
  - The kVp must be accurate:
    - If you set 80 kVp, the average energy will be 80 kVp.
  - The exposure must be linear:
    - 200 mA will produce twice as much radiation as 100 mA
  - Exposures must be reproducible:
    - 80 kVp @ 10 mAs must produce the same quantity of radiation time after time on that machine.
    - The Automatic Exposure Control (AEC) must produce the same quantity of radiation exposure after exposure.

Before you develop techniques

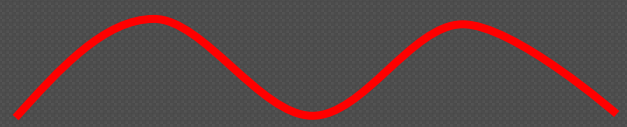
- Perform QC recommended by the manufacture
- Make sure your IR and plate reader have been calibrated by the service engineer

Good Technique

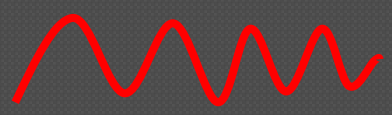
1. The goal of good technique is to <u>penetrate the anatomy</u> correctly and deliver the
2. <u>appropriate quantity of radiation</u> to the image receptor.

Penetrate the Anatomy

- kVp controls the penetrating ability of the beam
- Higher kVp higher energy x-rays
- Higher energy shorter wavelengths
- Shorter wavelength more penetrating



26 kVp

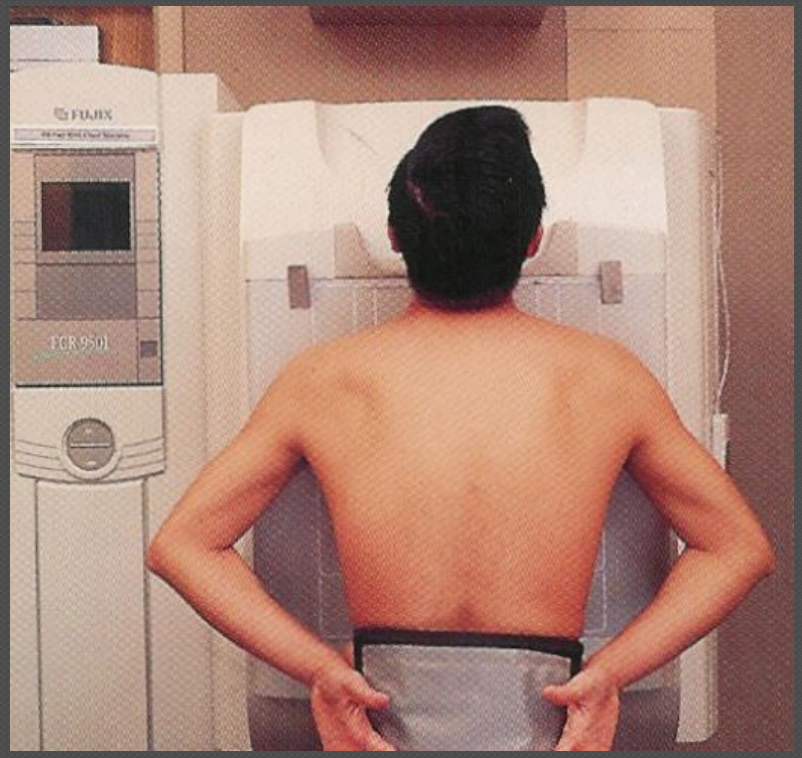


110 kVp

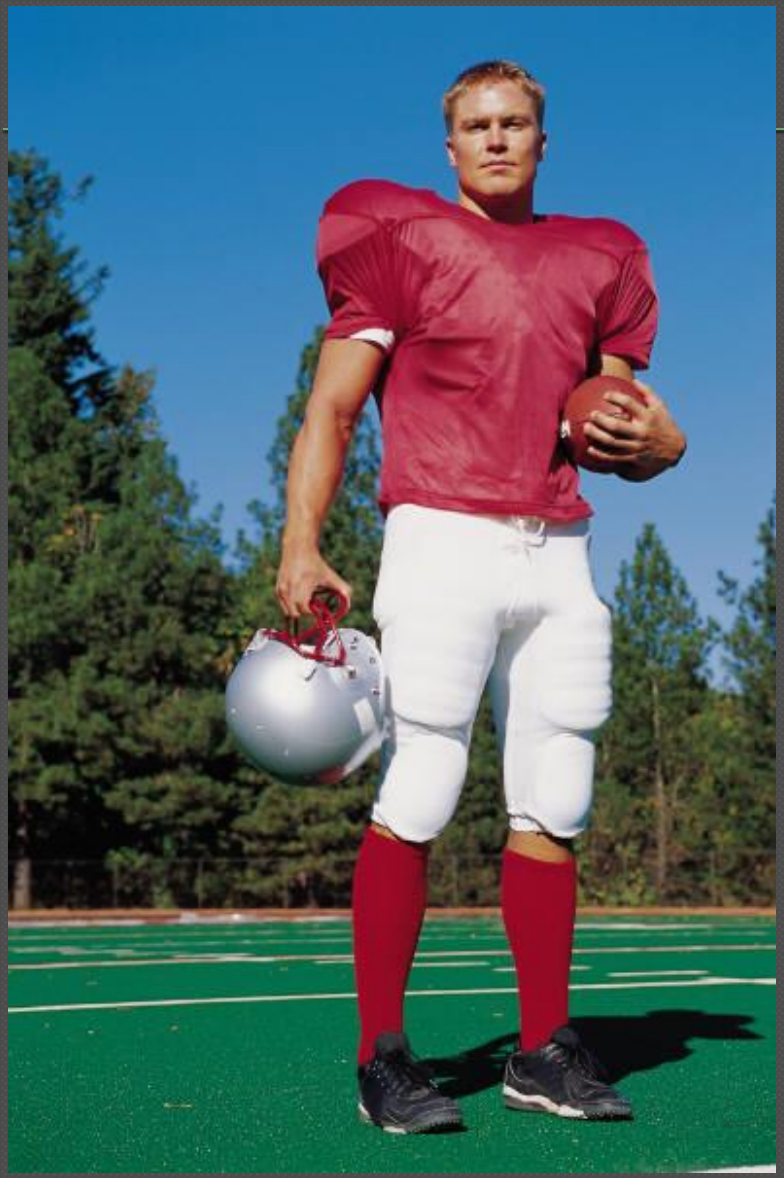
Penetrate the Anatomy

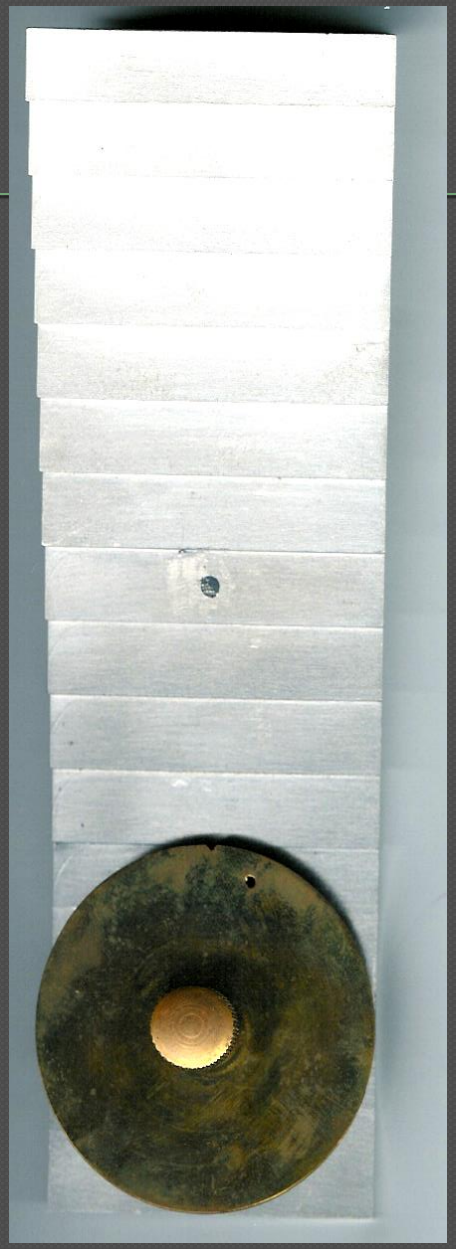
26 kVp

110 kVp



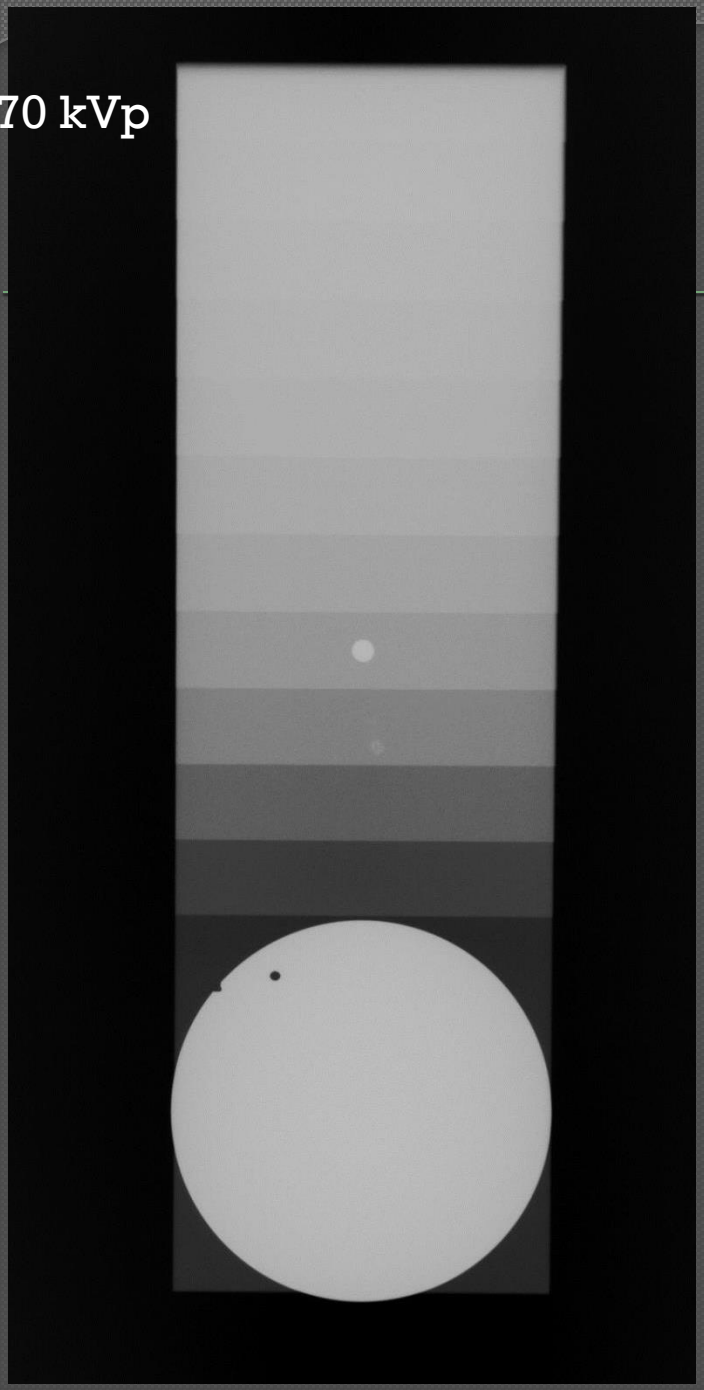
The best kVp for the average person is not optimum for everyone.

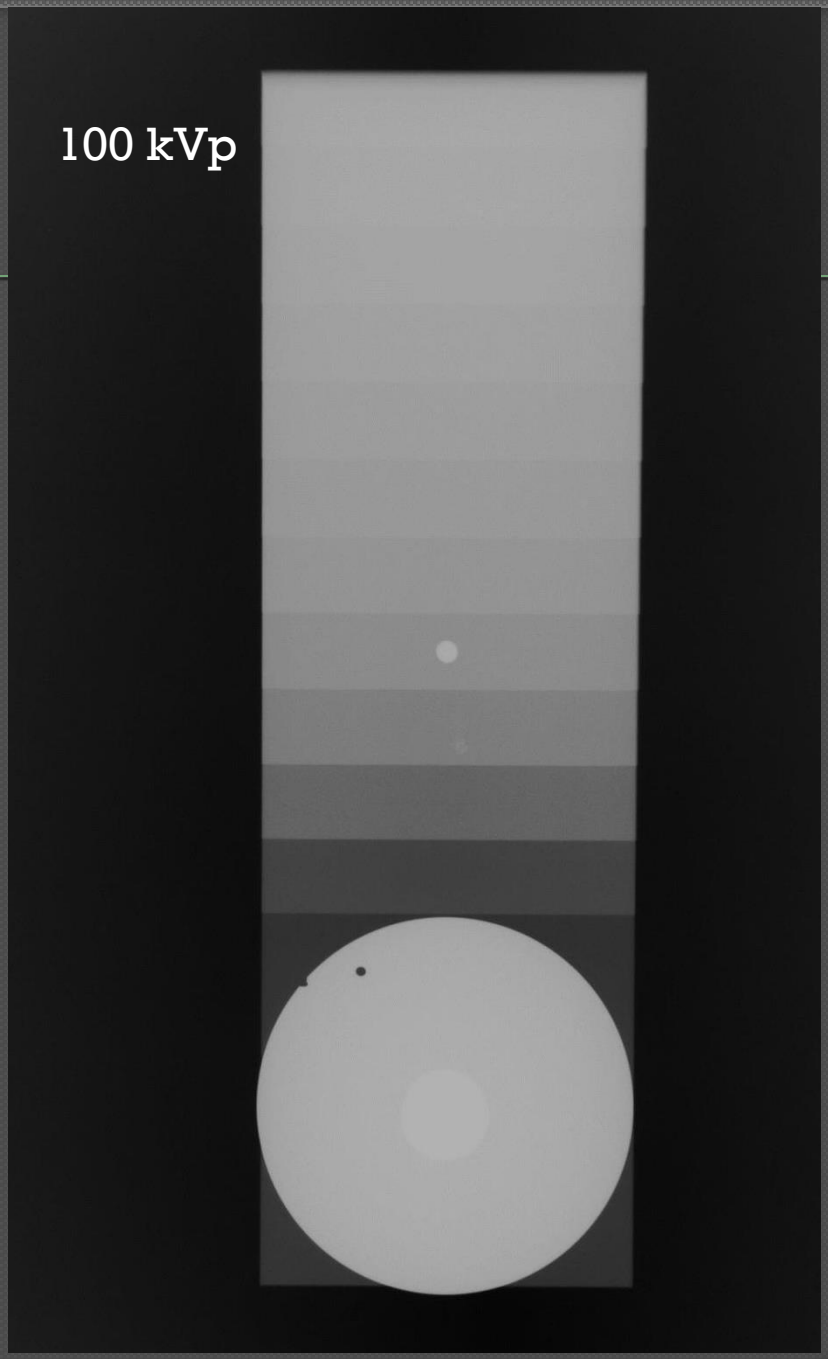


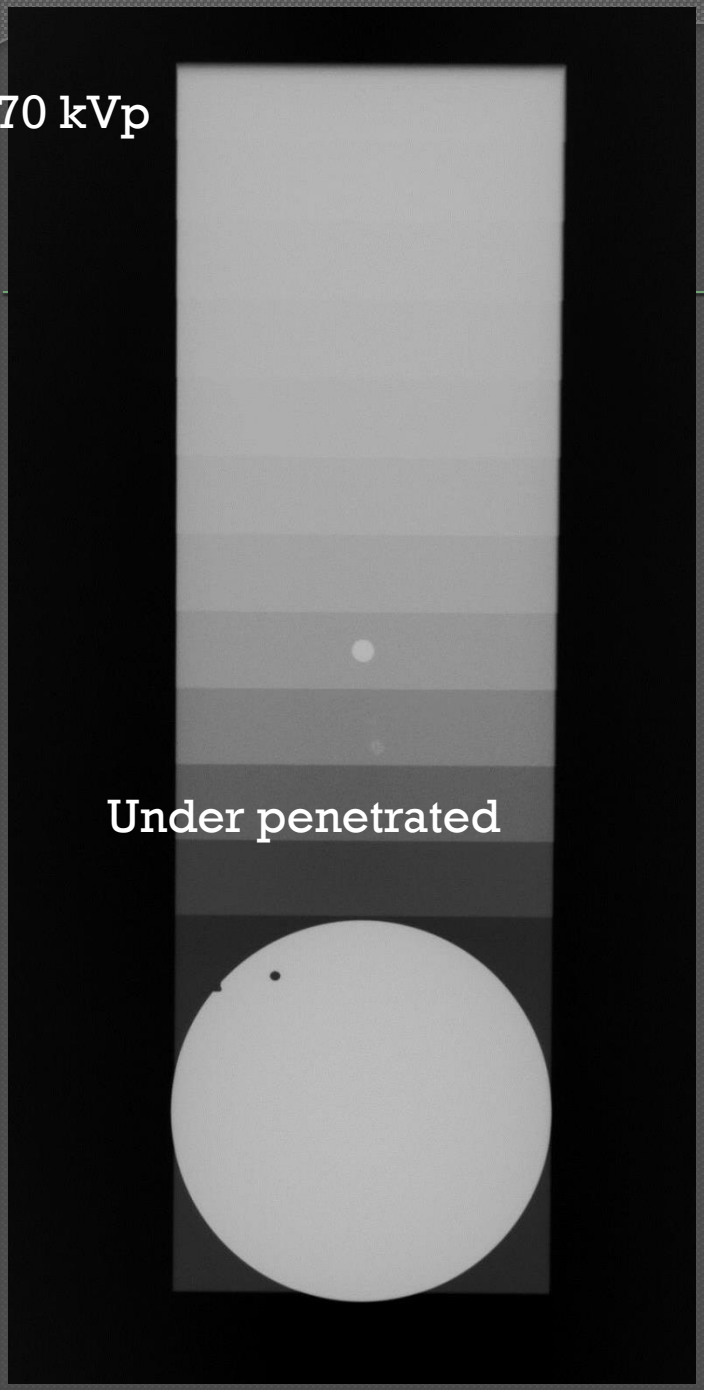


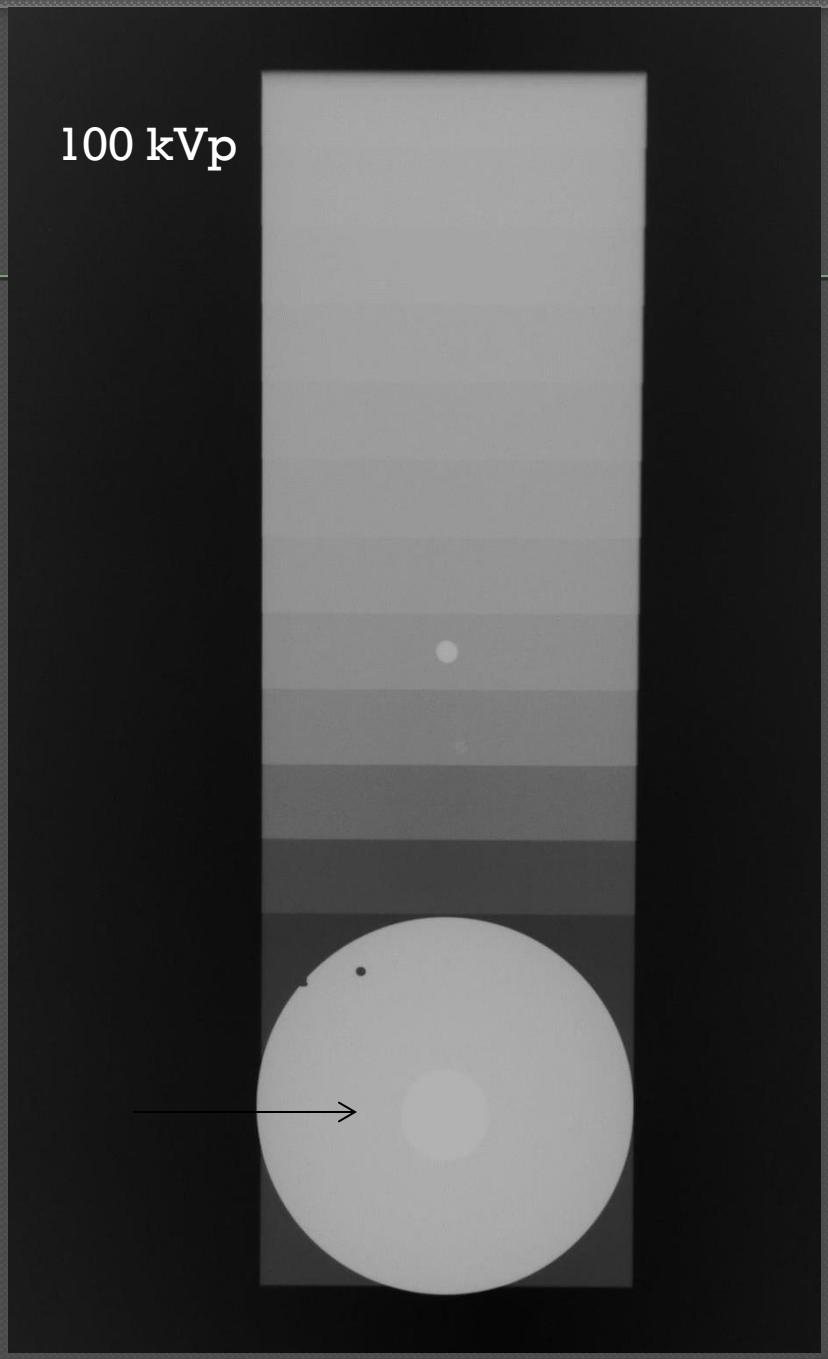
Testing the effect of changes in kVp

Aluminum step wedge with a spinning top

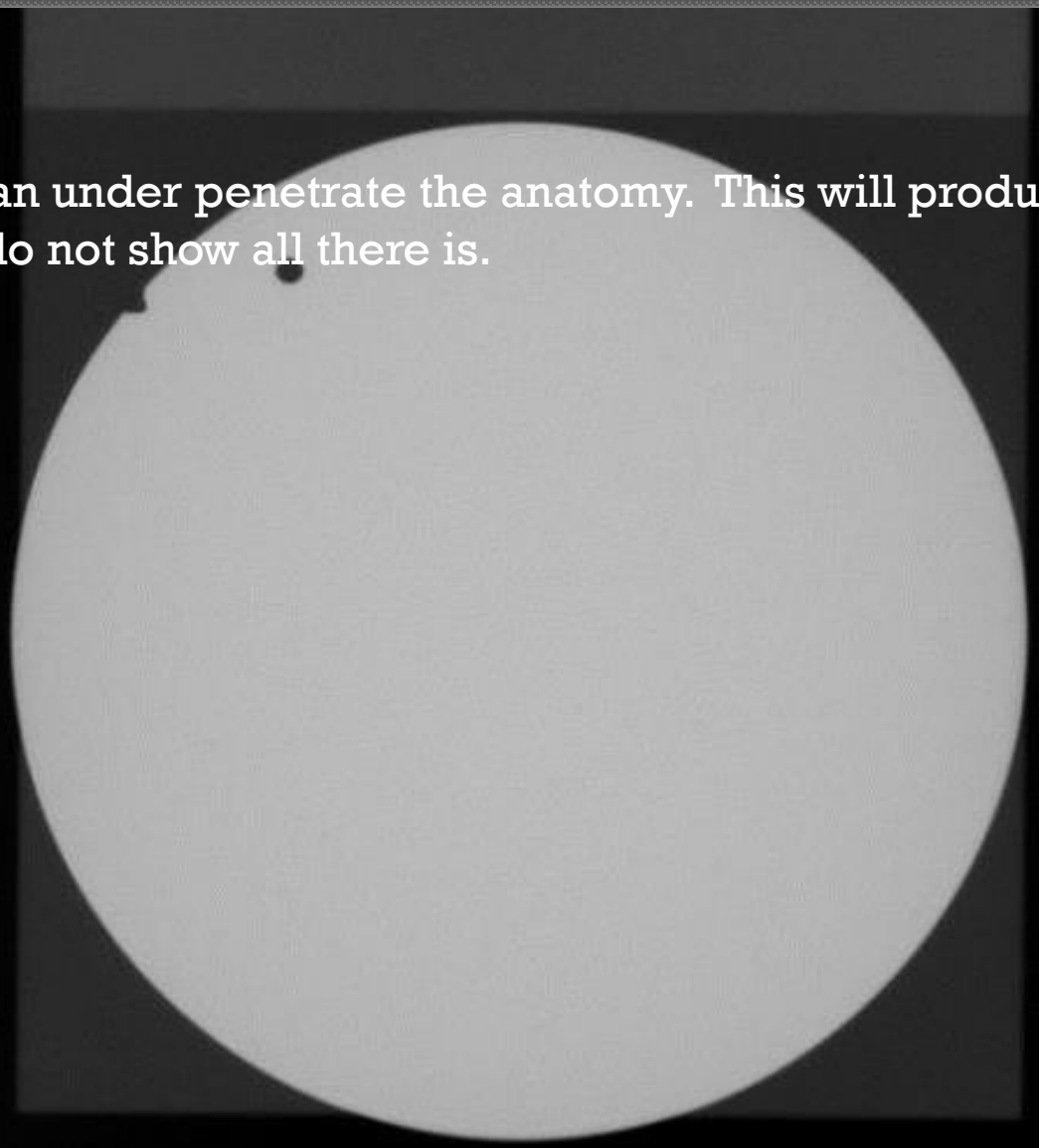

70 kVp


100 kVp

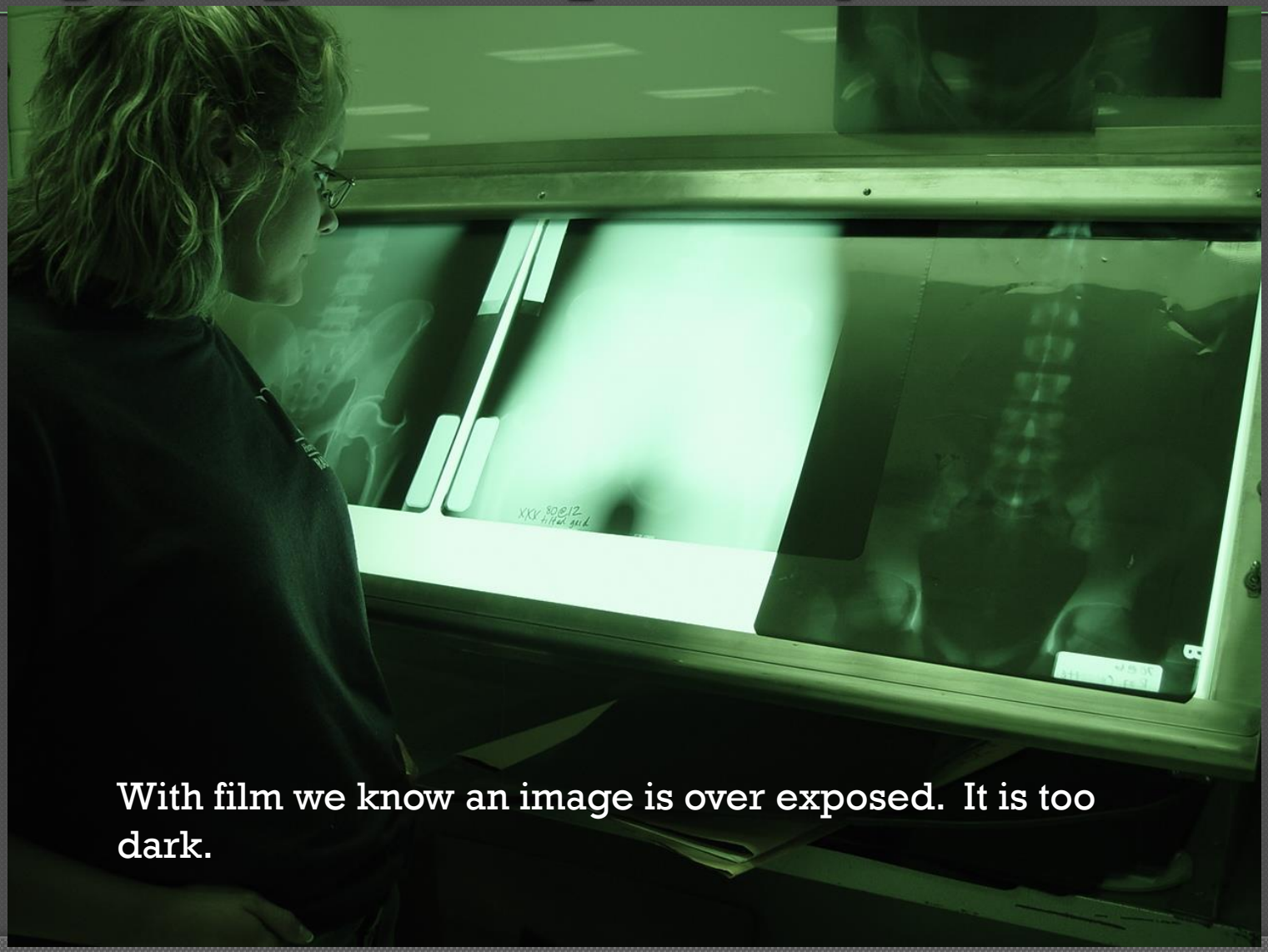

70 kVp
Under penetrated


100 kVp

Lower kVp can under penetrate the anatomy. This will produce images that do not show all there is.



Appropriate quantity of radiation



With film we know an image is over exposed. It is too dark.

Appropriate quantity of radiation

- Now we have the exposure index
- The exposure index roughly tells us the quantity of radiation striking the image receptor
- Manufacturers give us a range to target for the best images and patient dose

Variation

- With everything exactly the same there can be variation in the EI.
- Fuji will vary ± 20%

Exposure latitude

- Exposure latitude: the range of exposures over which a diagnostic image can be produced.
- Film has a narrow latitude
  - If you doubled exposure the film would be too dark
  - If you cut the exposure in half the film would be too light
- Digital systems have a wide exposure latitude.
  - Range is 0.01 mR to 10 mR on the IR

The right mAs

- When the mAs is too high you are over exposing the patient to unnecessary radiation
- If the mAs is too low you will get noisy images

Slightly over exposed

Gross under exposure

Appropriate quantity of radiation

- mAs controls the quantity of radiation

$$\frac{mAs_1}{mAs_2} = \frac{mR_1}{mR_2}$$

- kVp also controls the quantity of radiation

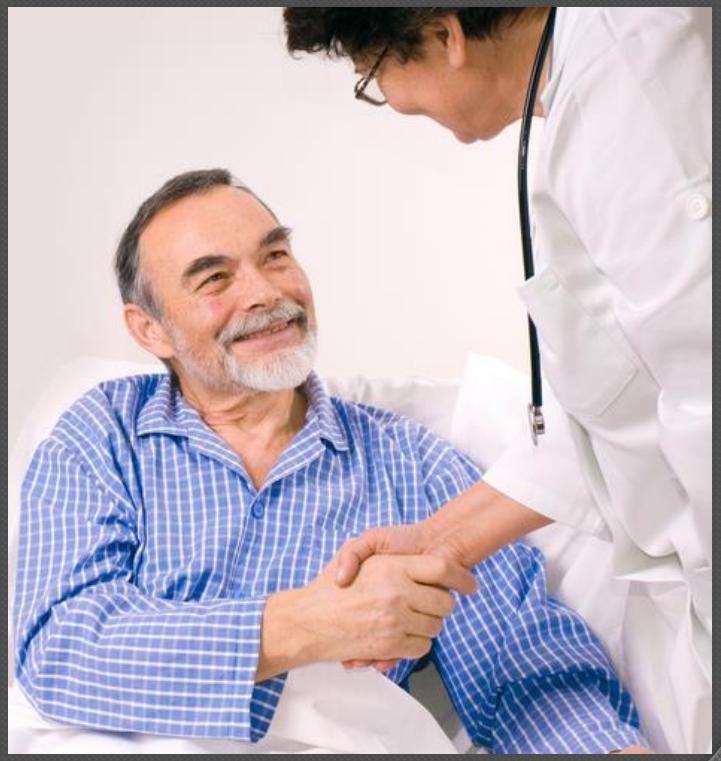
$$\frac{kVp_1^2}{kVp_2^2} = \frac{mR_1}{mR_2}$$

Latitude

- Digital image receptors have a wide latitude of exposures
- Fuji has a range of exposure index values of 100 S to 400 S
- This is a range of exposure of 4 times
- Let's say you shoot an abdomen 80kVp @ 40 mAs and get 100 S.
- You can cut to 10 mAs and get 400 S.

Reduce Patient Dose

- You are still in the acceptable range but you have cut the patient dose to ¼ of the original amount.



Choose your own range

- When you make your technique chart choose your target exposure index.
- Choose a target that is on the low radiation side of the range.
- If you have a Fuji system set your target at 300 S.
- Show the images to the radiologist for approval
- Make you chart based on the technique you used.

FUJIFILM

Computed Radiology Exposure Guide

Sunrise 70@5
Axillary 65@4.

Anatomical Region	Measurement (cm) Medium	Exam	KVP	SID	Grid	Small	Medium MAS	Large
Skull	18 to 21	Skull PA/AP	80	40	Yes	12	20	30
	14 to 17	Skull Lateral	80	40	Yes	6	12	18
S#200-400	18 to 21	Skull Townes, Waters	85	40	Yes	12	24	40
	14 to 17	Facial Bones Lat. (Bucky)	80	40	Yes	6	10	12
	14 to 17	Facial Bones Lat. (Non-Bucky)	60	40	No	2	4	6
	18 to 21	Nasal Bones (Non-Bucky)	60	40	No	2	3	4
Spine	11 to 14	Cervical AP/OBL	80	40	Yes	6	12	18
	11 to 14	Cervical Lateral	80	72	Yes	18	28	45
S#200-400	11 to 14	Cervical Odontoid	80	40	Yes	8	14	20
	21 to 25	C-7/T-1 Swimmers	85	40	Yes	24	40	64
	20 to 24	Thoracic AP/OBL	80	40	Yes	18	28	40
	28 to 32	Thoracic Lateral	85	40	Yes	25	35	50
	18 to 22	Lumbar Spine AP/OBL	80	40	Yes	24	40	64
	27 to 32	Lumbar Spine Lateral	85	40	Yes	30	64	100
	27 to 32	Lumbar L-5/S-1 Spot	90	40	Yes	30	64	100
Chest	20 to 25	Chest PA	110	72	Yes	4	6	10
	27 to 32	Chest Lateral	110	72	Yes	8	12	20
S#200-400	20 to 25	Chest Portable (GRID)	100	72	Yes	5	6	8
	20 to 25	Chest Portable (Non-GRID)	85	72	No	3.2	5	6
		(GRID)	95	60	Yes	3.2	5	6
		(GRID)	90	40	Yes	2	3.2	5
Thorax	20 to 25	Sternum RAO	80	40	Yes	20	30	40
	27 to 32	Sternum Lateral	85	40	Yes	30	40	50
S#200-400	20 to 25	Ribs AP/PA/OBL Upper	70	40	Yes	15	25	40
	20 to 25	Ribs AP/PA/OBL Lower	80	40	Yes	20	36	50
Shoulder	12 to 16	Shoulder AP	80	40	Yes	6	12	15
	4 to 6	Shoulder Axillary (Non-Bucky)	70	40	No	3	5	8
S#75-200	12 to 16	Scapula AP	80	40	Yes	10	20	36
	13 to 17	Scapula Lateral	80	40	Yes	12	24	40
Abdomen	18 to 22	Abdomen - KUB	80	40	Yes	24	40	64
	18 to 22	Abdomen - Upright/Decubitus	85	40	Yes	28	48	64
S#200-400	18 to 22	Barium Studies (GI, BE)	100	40	Yes	AEC	AEC	AEC
	18 to 22	Contrast Studies (IVP, GB)	80	40	Yes	AEC	AEC	AEC
Pelvis	19 to 23	Pelvis AP	80	40	Yes	24	40	64
S#200-400	17 to 21	Hip	80	40	Yes	20	35	50
	17 to 21	Hip X-Table Lateral	85	40	Yes	25	40	60

Technique conversion

- Convert the technique

$$\frac{mAs_1}{mAs_2} = \frac{S_2}{S_1}$$

$$\frac{\text{Old mAs}}{\text{New mAs}} = \frac{\text{New S}}{\text{Old S}}$$

$$\frac{\text{40 mAs}}{\text{New mAs}} = \frac{\text{New 400 S}}{\text{Old 100 S}}$$

Making a fixed kVp chart

- Once you have a good technique
- Measure the patient or the phantom
- When the thickness measurement increases 6 cm double the mAs

cm	kVp	mAs	SID	Grid
22	80	20	40”	bucky
23	80		40”	bucky
24	80		40”	bucky
25	80		40”	bucky
26	80		40”	bucky
27	80	40	40”	bucky

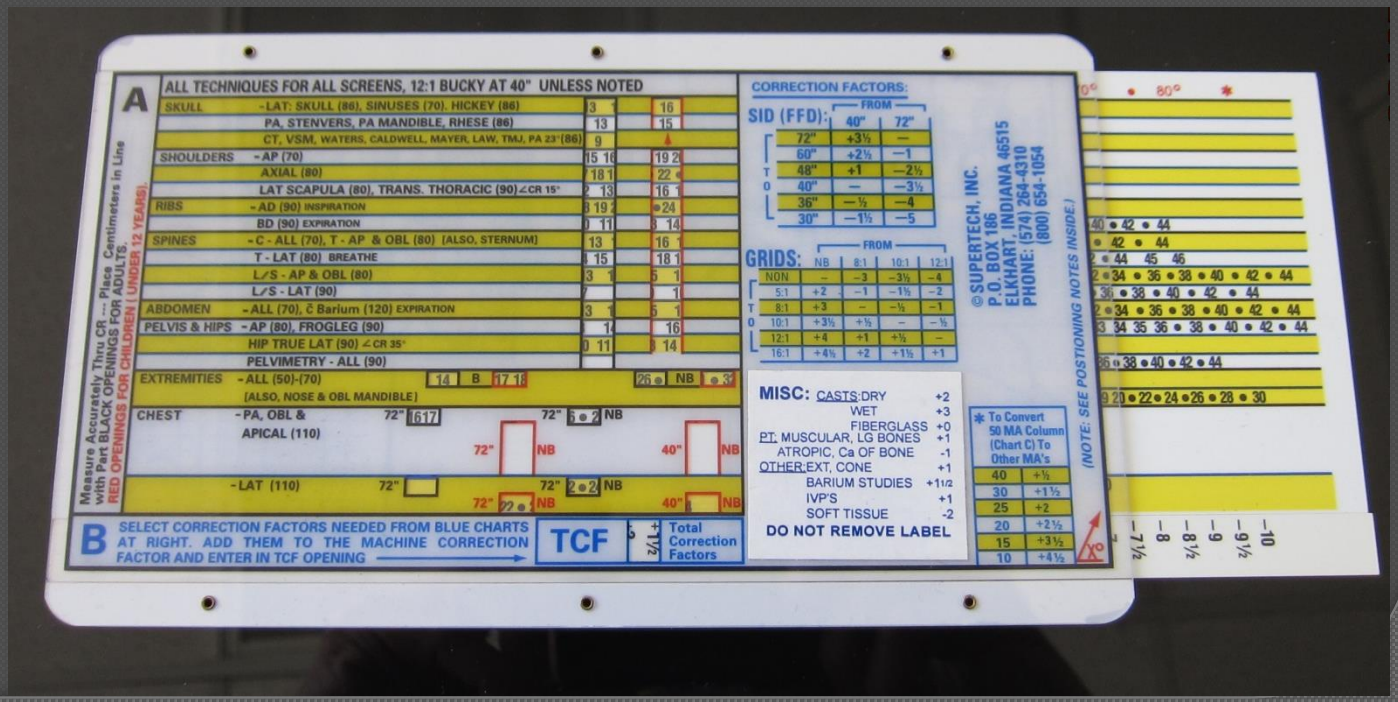
Making the chart

KUB	Room 1			
cm	kVp	mAs	SID	Grid
16	80	10	40”	Table bucky
17	80	12	40”	Table bucky
18	80	15	40”	Table bucky
19	80	17	40”	Table bucky
21	80	18	40”	Table bucky
22	80	20	40”	Table bucky
23	80	25	40”	Table bucky
24	80	28	40”	Table bucky
25	80	30	40”	Table bucky
26	80	35	40”	Table bucky
27	80	40	40”	Table bucky

Short cut

With a Supertech calculator you can make a technique chart with only one good technique.

Caution: Same grid, same tube, same SID, same IR

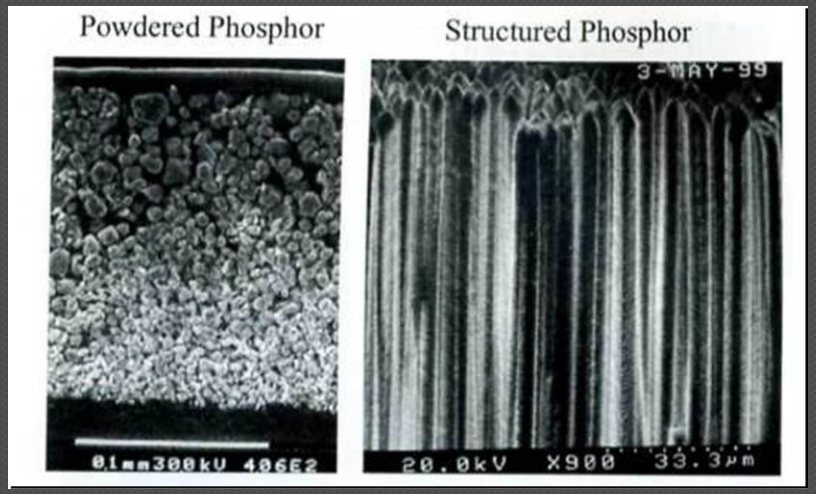


Each x-ray unit with have a unique technique chart

- X-ray generators have a wide variety of designs.
- With the same technique high efficacy generators produce x-ray exposures with more radiation and higher quality radiation. You can't use the same technique in Room 1 as Room 2.
- The grid in the bucky can vary greatly in the quantity of radiation absorbed.

If you change image receptors..

- The design of the image receptor will determine the efficiency of absorbing and using the radiation present.
- If you change the IR system, you may need to modify the chart.



Test the chart

- Test the chart yourself for a while to be sure it works before turning it over to everyone.
- If you have anatomic programing save the new techniques
- Communicate

We use AEC for everything!

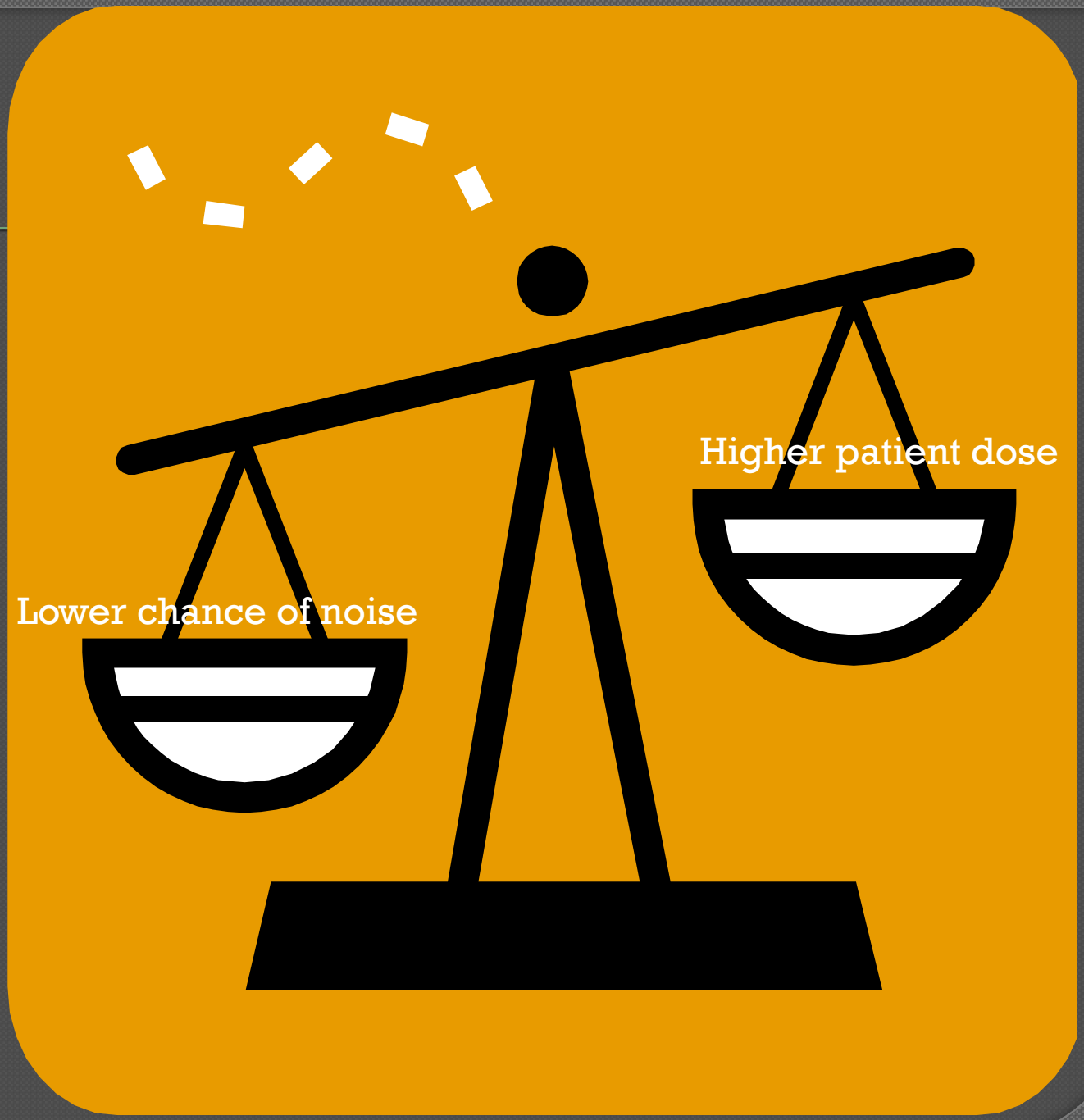
- The service engineer can adjust the AEC to give you an exposure at your target EI value.

- Use a phantom for this process.
- Shoot and adjust
- If you don't have a phantom borough one from the radiology school


Adjustments to the chambers to increase or decrease radiation levels.

S value Indicates the quantity of radiation striking the image receptor

Higher mAs exposures



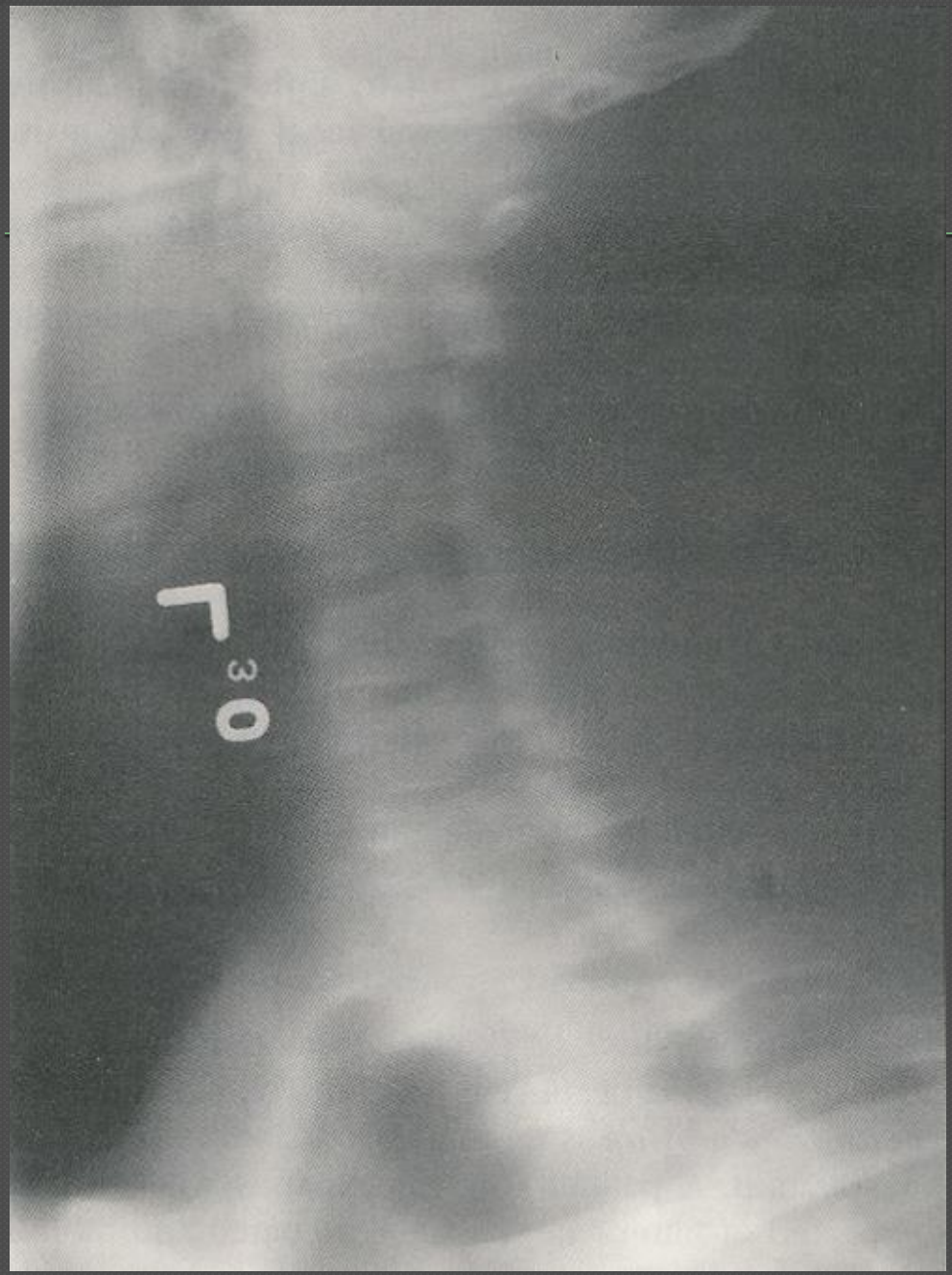
Don’t start a technique chart until you are sure the equipment in calibrated and QC is within limits.

Where do I start?

- Start with procedures that are the most frequently performed

Details

- When you make the technique chart be sure the technical factors are selectable on the operator's consol.
- Don't use 81 kVp @ 3.2 mAs, 72" SID if that is not available on the controls.



Long exposure times

To reduce the chance of motion

- Use a shorter exposure time.
- 100 mA @ 0.5 sec = 50 mAs
- 400 mA @ 0.125 sec = 50 mAs
- Both these exposures will produce the same quantity of radiation.

If you want motion…

- To use breathing technique choose a lower mA station and keep the mAs constant. This will produce a longer exposure time.
- 200 mA at 0.5 sec. (100 mAs) is not blurring the ribs
- Go to a lower mA station like 50 mA, keep the mAs the same and find the new time.
- 100 mAs/50 mA= 2 sec.

That technique didn't work!

- Don't through out the chart if it is off for one patient.
  - It might be the patient.

That technique didn't work!

- If your technique chart has been working for months and suddenly you are getting exposure indicator values that are off…
- There is a system change somewhere.
- Check the plate reader. The signal output from the PM tube can drift. This produces an EI that indicates low radiation levels when that is not the case.
- The radiation output on the x-ray machine may need calibrated.

"The best practice is to select the appropriate exposure
technique factors for the patient's size and condition,
based on a planned exposure system designed in collaboration with radiologists, to determine adequate image quality for diagnosis."

Best Practices in Digital Radiography

Recommended reading

- Learn more on digital imaging
- Overview of Digital Detector Technology
- http://www.aapm.org/meetings/05am/pdf/18-2623-22086-53.pdf

- ASRT White Paper
- Best Practices in Digital Radiography
- http://www.asrt.org/docs/whitepapers/asrt12_bstpracdigradwhp_final.pdf

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