1

IS IMAGE BRIGHTNESS AFFECTED WITH DIGITAL RADIOGRAPHY?

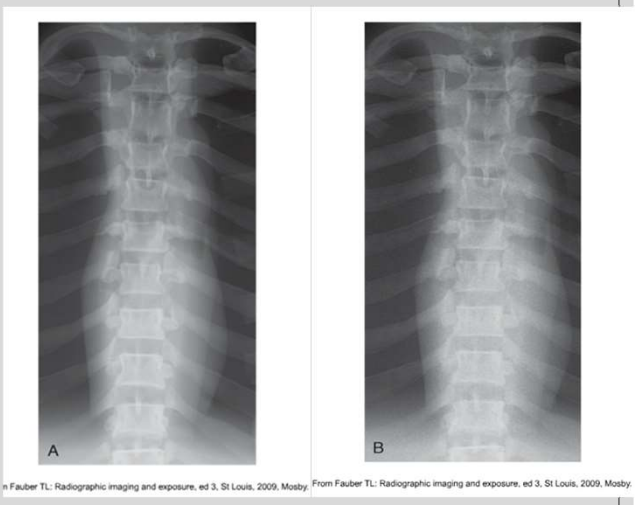
Answer: Brightness remains unchanged

2

Image Brightness

- Digital image processing can compensate for exposure errors and **maintain** brightness
  - Under exposure may result in increased quantum noise (but brightness maintained).
  - **Extreme** over exposure may result in saturation. (brightness will be insufficient)

Quantum Noise



n Fauber TL: Radiographic imaging and exposure, ed 3, St Louis, 2009, Mosby. From Fauber TL: Radiographic imaging and exposure, ed 3, St Louis, 2009, Mosby.

3

WHAT NEEDS TO DONE IF AN IMAGE APPEARS BLURRY DUE TO INVOLUNTARY MOTION?

Answer: Adjust Time

4

To Correct for Motion = ↓ Time

400 mA 66 ms @ 75 kVp

Which do you think would be the proper adjustment?

400 mA 132 ms @75 kVp

400 mA 33 ms @ 75 kVp

800 mA 66 ms @ 75 kVp

800 mA 33 ms @ 75 kVp

Remember you have to maintain technique for a proper exposure too.

5

WHAT WOULD HAPPEN IF YOU DOUBLE MAS AND DECREASE KVP BY 15%?

Answer: Technique will be maintained

6

- 10 mAs @ 90 kVp changed to 20 mAs @ _____ kVp
  - mAs doubled so what needs to be done to kVp to **maintain** receptor exposure?
  - Calculate 15% of 90? _____; **Subtract** this from 90 to get new kVp value

20 mAs @ 77 kVp

This keeps the same exposure

If we would have increased kVp by 15% what would have happened?.....

Doubled the Exposure

7

WILL CHANGING THE FOCAL SPOT AFFECT PATIENT DOSE?

Answer: NO

8

Focal Spot

- Focal spot size affects sharpness
- Small focal spot = better image sharpness (spatial resolution)
- **Best practice** – use smallest size available

- It does not affect patient dose!

9

WILL CHANGING SID WHILE USING THE SAME TECHNIQUE AFFECT PATIENT DOSE?

Answer: Yes

10

SID and Receptor Exposure

- Affects the amount of radiation reaching the patient and the receptor exposure.
- SID and receptor exposure/patient dose are inversely related (Inverse square law)
  - As SID is increased, the x-ray intensity is spread over a larger area. This decreases the overall intensity of the x-ray beam reaching the IR.

Double SID, receptor exposure would be 75% (1/4) of original intensity
Halve SID, receptor exposure would be 4x what it was.

The Inverse Square Law

$$\frac{I_1}{(I_2)} = \frac{(d_2)^2}{(d_1)^2}$$

I_1 is the initial intensity of radiation, d_1 is the initial distance, and d_2 is the final distance, and I_2 is the final intensity.

11

WITH MANUAL TECHNIQUE, WOULD A LONGER OR SHORTER SID CAUSE AN INCREASE IN PATIENT DOSE WHEN USING THE SAME TECHNIQUE?

Answer: Shorter

12

HOW WOULD YOU MAINTAIN AN EXPOSURE WITH A CHANGED SID?

Answer: Direct Square Law or Exposure Maintenance Formula

13

Direct Square Law or Exposure Maintenance Formula

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

mAs_1 = original mAs

mAs_2 = new mAs

SID_1 = original SID

SID_2 = new SID

14

First x-ray taken using 20 mAs and 40" SID. What new mAs should you use to maintain the receptor exposure if you were to increase SID to 66"?

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

$mAs_1 = 20$
$mAs_2 = ?$
SID1 = 40inches
SID2 = 66 inches

$\frac{20}{X} = \frac{40^2}{66^2}$ 1600 4356

$4356(20) = 1600x$

87,120/1600 = **54 mAs**

15

WHEN SID DECREASES, WHEN WOULD THE MAS HAVE TO BE ADJUSTED?

Answer: Greater than 15% change in SID

16

Greater than 15% change in SID

- Change mAs when *Significant* SID change - **Greater than 15% change**
- Decrease in SID = decrease in mAs
- Increase in SID = increase in mAs

- **If elbow is only able to be obtained with a 33" SID, how would you adjust mAs?**
- - this is greater than 15% (more than 6 inches), need to **decrease** your mAs station by **25%**
  - 25% is typically **one mAs station** on the console

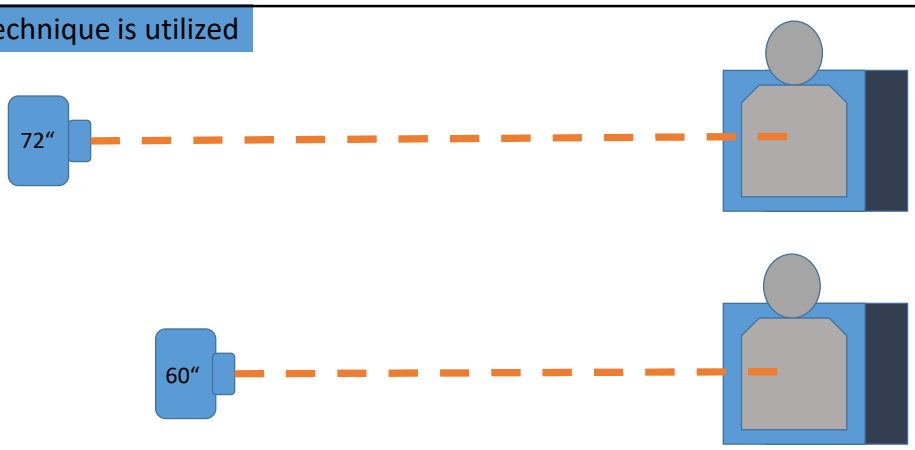
17

WHEN USING AEC, WILL CHANGING SID WHILE USING SAME TECHNIQUE AFFECT EXPOSURE TIME?

Answer: Yes

18

If same technique is utilized



If using a shorter distance, the x-ray photons will reach the AEC chambers faster causing a shorter exposure time. *(Reference voltage will be met faster.)*

If using a longer distance, the x-ray photons will reach the AEC chambers faster causing a longer exposure time.

There would be no change in the image.

19

WHAT DO YOU NEED TO DO WHEN A PATIENT PART THICKNESS VARIES WITH A VARIABLE KVP-FIXED MAS TECHNIQUE CHART?

Answer: adjust kVp up or down by 2 for every one cm different

20

Adjust kVp by 2 for every 1-cm

- kVp can be increased as the anatomic part size increases
- Baseline kVp is increased **by 2 for every 1-cm** increase in part thickness with the mAs being maintained
- Accurate measurement of part thickness is critical to be effective

Knee (10 cm) – 63 kVp @ 8 mAs
Knee (14 cm) - ?? kVp @ 8 mAs

4 cm **increase** = 4 x 2 = 8

63 kVp + 8 kVp = 71 kVp

21

WHAT TECHNIQUE WILL LEAD TO THE LEAST AMOUNT OF DOSE TO THE PATIENT?

Answer: High kVp with low mAs

22

High kVp with Low mAs

- If optimum kVp value is used with a lower mAs – patient exposure is reduced and image quality is still sufficient.
- Lowest kVp value that provides necessary penetration – will lead to a higher patient dose because it will need to use a higher mAs value

Also increases tube life!

23

WHAT WILL OCCUR TO PATIENT DOSE IF A GRID IS ADDED?

Answer: Increase

24

Grids

- Grids are typically used only when the anatomic part is 10 cm (4 inches) or greater in thickness, and more than 60 kVp is needed for the exam.
- Grids absorb some radiation = an **increase in mAs**
- mAs must be adjusted to maintain exposure to the IR
- The more efficient a grid is in absorbing scatter, the greater the increase in mAs

Grid Conversion Factors	
Grid Ratio	**Conversion Factor**
6:1	3
8:1	4
10:1	5
12:1	5
16:1	6

- **Grid added – increase mAs**
- **Grid removed – decrease mAs**

25

You perform a portable chest x-ray on a DR unit and a grid (8:1) is required due to a 32cm measurement. Technique book states 28cm chest non grid 4mAs @ 85 kVp. What would be you grid conversion technique used?

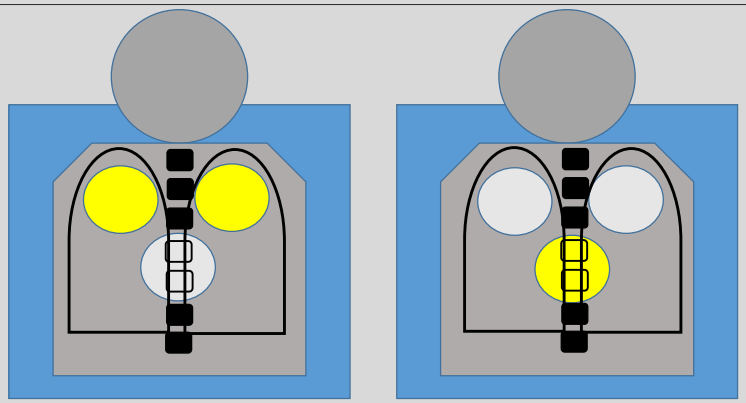
- 8:1 grid = conversion factor of 4
- 4 mAs x 4 = 16 mAs
- Remember, there was also a measurement difference → 28 cm to 32 cm
  - 32 – 28 = 4 cm difference
  - For every 1 cm = 2 kVp change
  - 4 x 2 = 8 Kvp
  - 85 kVp + 8 kVp = 93 kVp

New Technique: 16 mAs @ 93 Kvp

26

WHEN USING AEC, WHAT FACTORS WILL BE AFFECTED WHEN A WRONG CELL IS SELECTED?

27



If Chest was the Area of Interest

*Increased exposure
*Longer exposure time

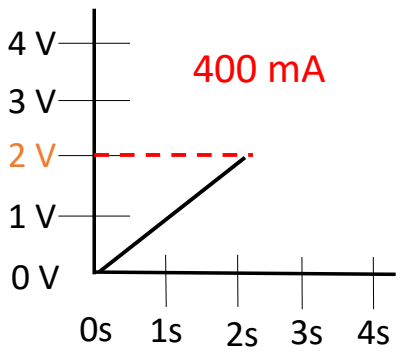
Using the 2 outer cells allows the area of interest (lungs) to be the primary focus, leading to appropriate exposure. When the center cell is used the area of interest would be the spine. Since the spine is denser than the lungs a longer exposure will occur to properly penetrate the spine. This causes a good exposure of the spine, but over exposure of the lungs.

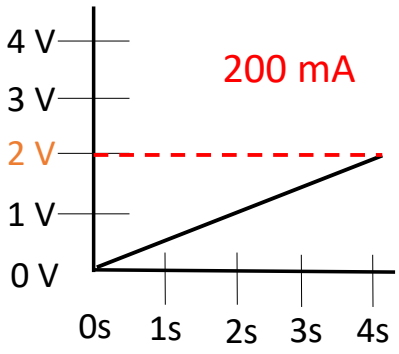
28

WHEN USING AEC, WILL CHANGING MA OR KVP AFFECT ANY FACTORS?

29

Changing kVp and/or mA while using AEC **will not** change image exposure.





It will change the time it takes for the exposure to be made to reach the density that is required for the image.

Here is why…2 V is the reference voltage (preset level) that determines the 'optimal' exposure level. With a 400 mA the reference voltage is reached in 2 seconds. If the mA is changed to 200 the reference voltage is reached in 4 seconds. If you decrease your mA, the machine will need a longer exposure time to reach the proper penetration that is adequate for the area of interest. There would be no change in the image.

30

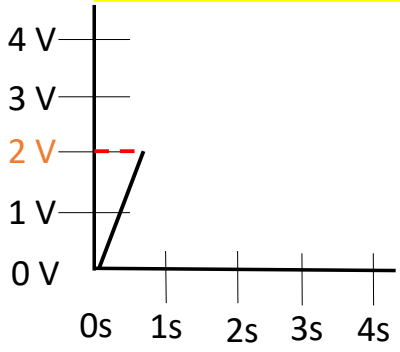
WHEN USING AEC, WILL CHANGING DENSITY AFFECT ANY FACTORS?

31

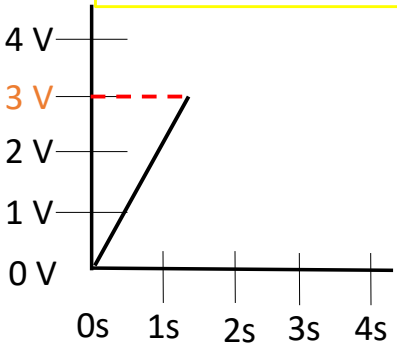
Density should only be adjusted when appropriate for patient body habitus or other aspects dependent on an increase or decrease in exposure indices

If Density is increased…

80k Vp, 400 mA and **Normal** density



80 kVp, 400 mA and **+1** density



Increasing density, increases the set reference voltage. You are telling the system you need more exposure in order to obtain an 'optimal' exposure level for your patient/body part. The exposure will take more time to reach the higher reference voltage.

(Remember when you change the density setting, you are increasing your exposure by 25%.)

32