



TECHNICAL FACTOR REVIEW

MI 238

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IS IMAGE BRIGHTNESS AFFECTED WITH DIGITAL RADIOGRAPHY?

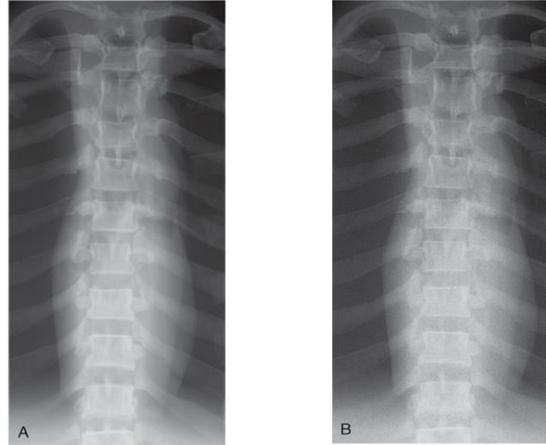
Answer: Brightness remains unchanged

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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.

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SINCE BRIGHTNESS CANNOT BE USED TO INDICATE THE QUALITY OF AN IMAGE, WHAT CAN BE USED?

Answer: Exposure Indicator

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Exposure Indicator

- Regardless of image appearance, the exposure index should always be verified to be in acceptable range



Which one has the incorrect EI?

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

Answer: Adjust Time

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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.

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HOW DO YOU CORRECT
QUANTUM NOISE?

Answer: increase mA or mAs

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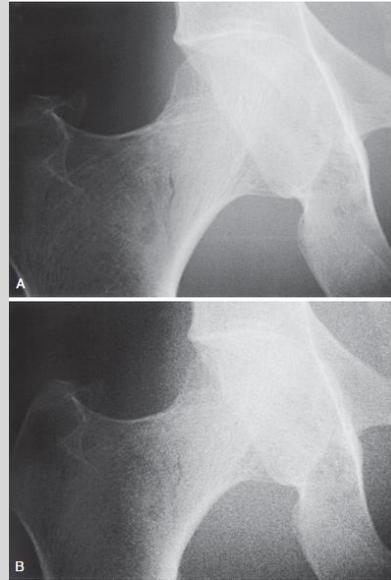
Quantum Noise

- Results from insufficient photon quantity reaching the IR
- Fewer photons reaching IR, greater the quantum noise

To correct Quantum Noise, you must increase the quantity of photons reaching the IR. Therefore you must:

Increase mA or mAs

But by how much????



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Milliamperage and Exposure Time

- Directly proportional to radiation **quantity**
- Directly proportional to amount of receptor exposure and therefore patient dose
- mA and exposure time are **inversely** related to each other to **maintain** receptor exposure
- For repeat images due to exposure errors:
 - **A minimum change involves doubling or halving the mAs.**
- So...if Quantum Noise is from insufficient photon quantity, what will you need to do to your mAs?

Double mAs

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Let work through a problem...

- Direct EI imaging system – appropriate EI range is 100-300. An AP Elbow was performed and had an EI of 75 using 1.4 mAs @ 70 kVp. What new technique would need to be used to get it within the appropriate range?

Need to double the mAs due to underexposure

$$1.4 \times 2 = 2.8$$

New Technique 2.8 mAs @ 70 kVp

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CAN KVP BE ADJUSTED INSTEAD
OF MAS FOR INSUFFICIENT EI?

Answer: Yes

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kVp

- Increasing the kVp increases IR exposure and patient dose
 - As kVp increases, receptor exposure increases ...but not in equal amounts
- Rule of thumb is that a **15%** increase in kVp will double receptor exposure.
- **No amount of mAs can compensate for insufficient kVp**

$$80 \text{ kVp} \times 0.15 = 12 \quad \text{New kVp} = 92 \text{ kVp}$$

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

Answer: Technique will be maintained

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- 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

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WILL CHANGING THE FOCAL SPOT
AFFECT PATIENT DOSE?

Answer: NO

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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!**

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

Answer: Yes

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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.

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

Answer: Shorter

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HOW WOULD YOU MAINTAIN AN EXPOSURE WITH A CHANGED SID?

Answer: Direct Square Law or Exposure Maintenance Formula

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Direct Square Law or Exposure Maintenance Formula

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

mAs₁ = original mAs

mAs₂ = new mAs

SID₁ = original SID

SID₂ = new SID

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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"?

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

$$\begin{aligned} mAs_1 &= 20 \\ mAs_2 &= ? \\ SID_1 &= 40 \text{ inches} \\ SID_2 &= 66 \text{ inches} \end{aligned}$$

$$\frac{20}{X} = \frac{40^2}{66^2} \quad \begin{array}{l} 1600 \\ 4356 \end{array}$$

$$4356(20) = 1600x$$

$$87,120/1600 = \mathbf{54 \text{ mAs}}$$

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

Answer: Greater than 15% change in SID

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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

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WHAT DO YOU NEED TO DO WHEN A
 PATIENT PART THICKNESS IS 4 TO 5 CM
 SMALLER OR LARGER WITH A FIXED
 KVP- VARIABLE MAS TECHNIQUE
 CHART?

Answer: adjust mAs

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Part Thickness and Attenuation

- A thick part absorbs more radiation and therefore decreases receptor exposure
 - Remember that for every 4-5 cm of tissue, x-ray photons are reduced by about 50%
 - How would this affect technical factor settings?

Original - 15 cm technique – 10 mAs
19 cm technique – what would you use? 20 mAs (2 x greater)
23 cm technique – what would you use? 40 mAs (4 x greater)

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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

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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** = $4 \times 2 = 8$

63 kVp **+ 8 kVp** = 71 kVp

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WHAT DOES BEAM RESTRICTION HELP WITH?

Answer: contrast and patient dose

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Beam Restriction

- Smaller field size (increasing collimation)
 - Decreases amount of tissue irradiated,
 - Less scatter produced
 - Decreases receptor exposure
 - Decreases patient dose
 - Higher radiographic contrast

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

Answer: High kVp with low mAs

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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

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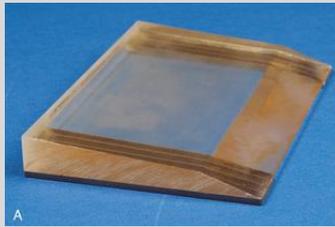
WHEN USING A COMPENSATING
FILTER, WILL PATIENT DOSE
INCREASE OR DECREASE?

Answer: Increase

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Compensating Filters

- Compensating filters are used on body parts that vary great in tissue thickness
- Produces a more uniform exposure to the IR
- Requires an increase in **mAs** to maintain the overall exposure to the image receptor.



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

Answer: Increase

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



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ONE MORE THING TO REVIEW....

AEC

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You are using AEC for a KUB. Chart shows to use 85 kVp, 400 mA and all three cells at normal density. Describe what will happen to receptor exposure if you change each of the factors as indicated below (all other factors the same):

Use 60 kVp?

Exposure time:	★ Longer	Shorter	No change
Receptor Exposure:	Increased	Decreased	★ No change

Use single, center cell only?

Exposure time:	★ Longer	Shorter	No change
Receptor Exposure:	★ Increased	Decreased	No change

Use 600 mA?

Exposure time:	Longer	★ Shorter	No change
Receptor Exposure:	Increased	Decreased	★ No change

Use -1 density?

Exposure time:	Longer	★ Shorter	No change
Receptor Exposure:	Increased	★ Decreased	No change