

IMAGING AND OBESITY

Dr . Sameer Abdul Lateef

Heart of the Issue

"Every stage of an obese person's medical care is compromised because of their size, and that includes diagnosis and treatment."

The Extent of the US Obesity Epidemic

Overall, **66%** of Americans are overweight, obese, or morbidly obese, and currently **6 million** individuals are considered morbidly obese with a BMI greater than 40 kg/m².^[1]



Objectives

Imaging the obese patient

1. Impact on healthcare facilities and personnel
2. Health risks for the obese patient
3. Imaging risks for the obese patient

Objective 1: Effects on the Healthcare System

Consequences for imaging departments

- a. Weight and aperture limits for equipment
- b. Lifting and moving patients
- c. Scattered radiation – a health risk for radiology personnel

Table weight limits

- ▣ Ultrasound 500 lbs.(226.7 kg)
- ▣ MR 350 lbs.(158.7 kg)
- ▣ CT 450 lbs.(204.1kg)
- ▣ Nuclear Medicine 400 lbs.(181.4 kg)
- ▣ X-ray 485 lbs.(207.7 kg)
- ▣ 1 kg = 2.2 lb

Industry Standard Maximums

- ▣ **MRI: Weight: 350 pounds ; Aperture: 45 -50 cm**
- ▣ **(159 kg)**
- ▣ **CT: 425 – 450 pounds; 50 cm (204 kg)**

- ▣ **Nuclear: 400 pounds(181 kg)**

- ▣ **Fluoroscopy: 350 pounds; 45 cm (159 kg)**

- ▣ **Note: 50 cm diameter = @ 62 inches circumference**

Equipment: Waiting Areas



\$508

\$720



\$270.92



\$571.12

Wheelchairs



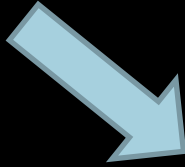
MRI

Aperture Limitations
45 - 50 cm (@ 62 " circumference)



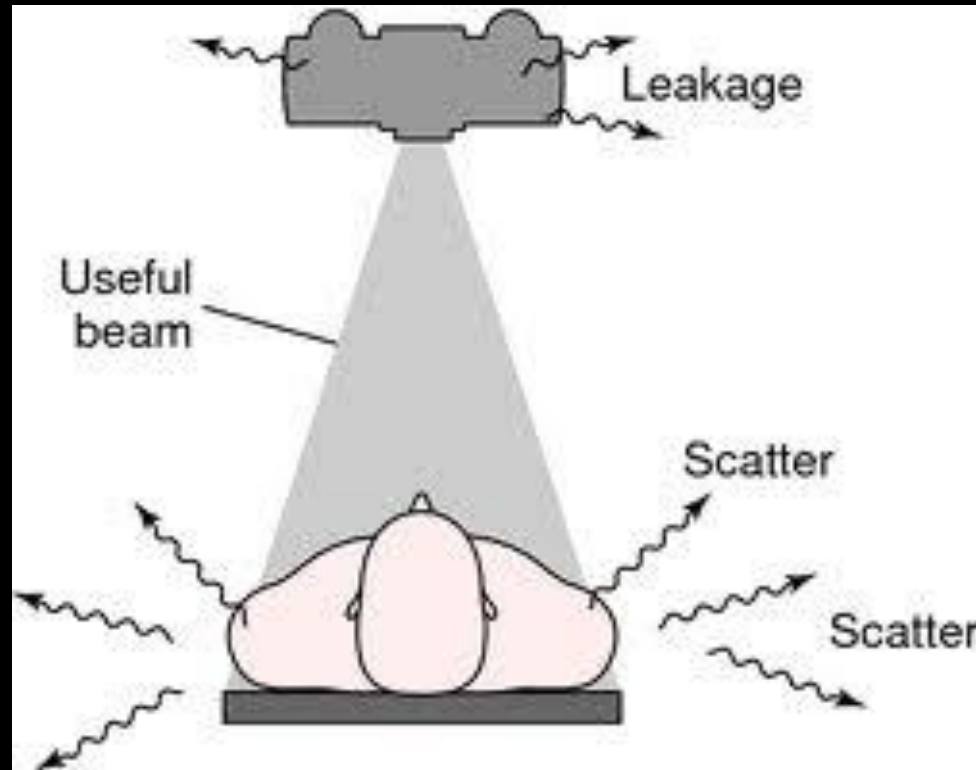


Lifting



During an 8-hour shift, a nurse may lift a total of 1.8 tons.

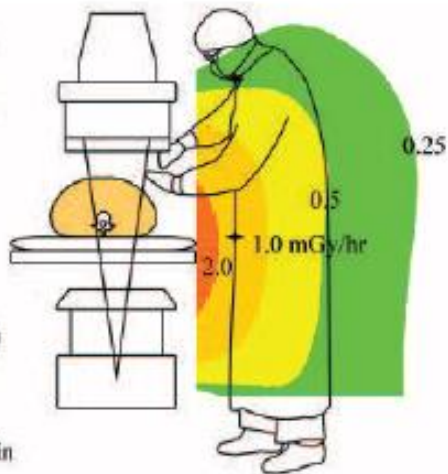




Large patient = More scatter = More exposure

Stray Radiation

Operator Collar:
0.44 mGy/hr
Operator Waist:
1.6 mGy/hr



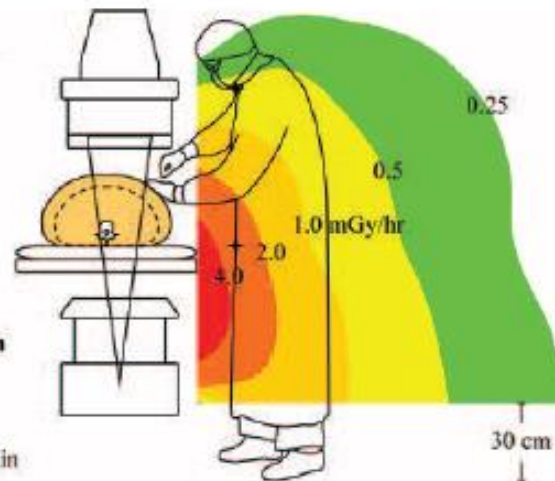
Primary Radiation

Phantom:
11 mGy/min
DAP:
180 cGy-cm²/min

a.

Stray Radiation

Operator Collar:
0.62 mGy/hr
Operator Waist:
3.0 mGy/hr



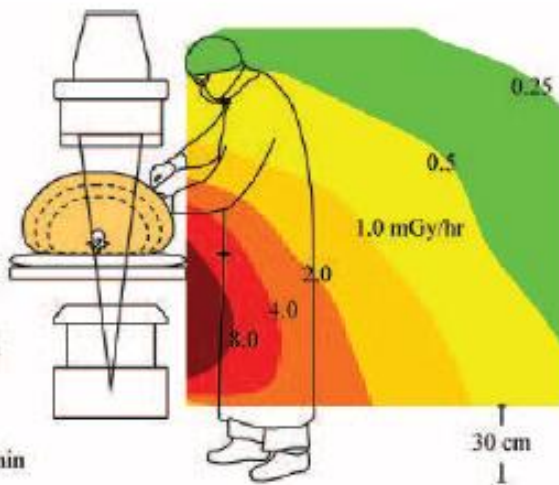
Primary Radiation

Phantom:
33 mGy/min
DAP:
460 cGy-cm²/min

b.

Stray Radiation

Operator Collar:
0.75 mGy/hr
Operator Waist:
5.7 mGy/hr



Primary Radiation

Phantom:
87 mGy/min
DAP:
1160 cGy-cm²/min

c.

Figure 5. Effect of increasing patient abdomen thickness on operator exposure. Drawings illustrate stray radiation isodose curves calculated with a phantom simulating abdomen thicknesses of 24 cm (a), 29 cm (b), and 34 cm (c).

“There is a significant increase in the stray radiation level as patient size increases”

Objective 2:

Health Consequences for the obese patient

Research has shown that as weight increases to reach the levels referred to as "overweight" and "obesity,"* the risks for the following conditions also increases:¹

1. Coronary heart disease
2. Type 2 diabetes
3. Cancers (endometrial, breast, and colon)
4. Hypertension
5. Dyslipidemia

Health Consequences of Obesity (cont.):

6. Stroke

7. Liver and Gallbladder disease

8. Sleep apnea and respiratory problems

9. Osteoarthritis

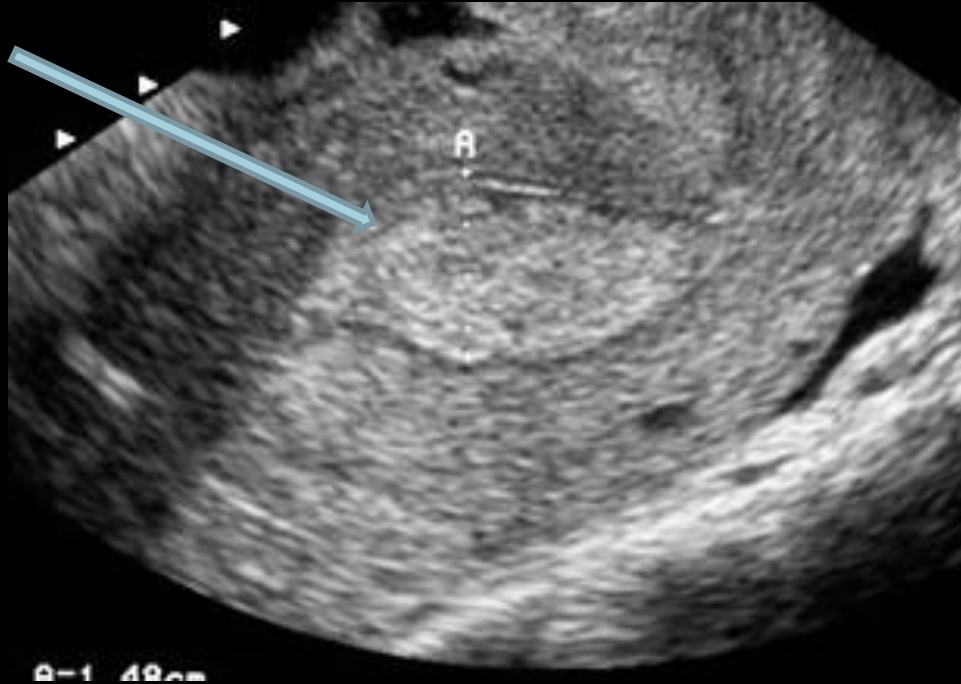
10. Gynecological problems (abnormal menses, infertility)



Obesity Risk Factors for CAD:

1. Abdominal obesity (fat around the waist)
2. Low HDL ("good") cholesterol
3. High triglyceride levels
4. High blood pressure
5. Insulin resistance

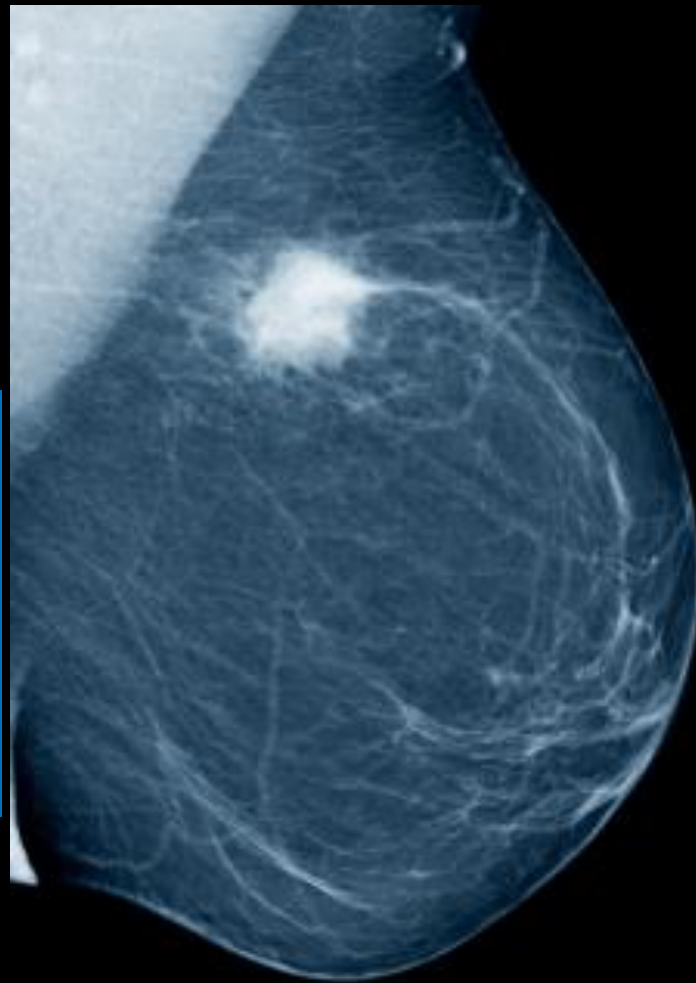
Endometrial cancer



“in the United States, obesity could be the reason for up to 40 percent of diagnosed cases of endometrial cancer. “

“BMI of 25 or greater were six times more likely to develop endometrial cancer than women of a healthier body weight”

Excess body weight has been linked to an increased risk of postmenopausal breast cancer, and growing evidence also suggests that obesity is associated with poor prognosis in women diagnosed with early-stage breast cancer.



REVIEW ARTICLE

Obesity and Breast Cancer

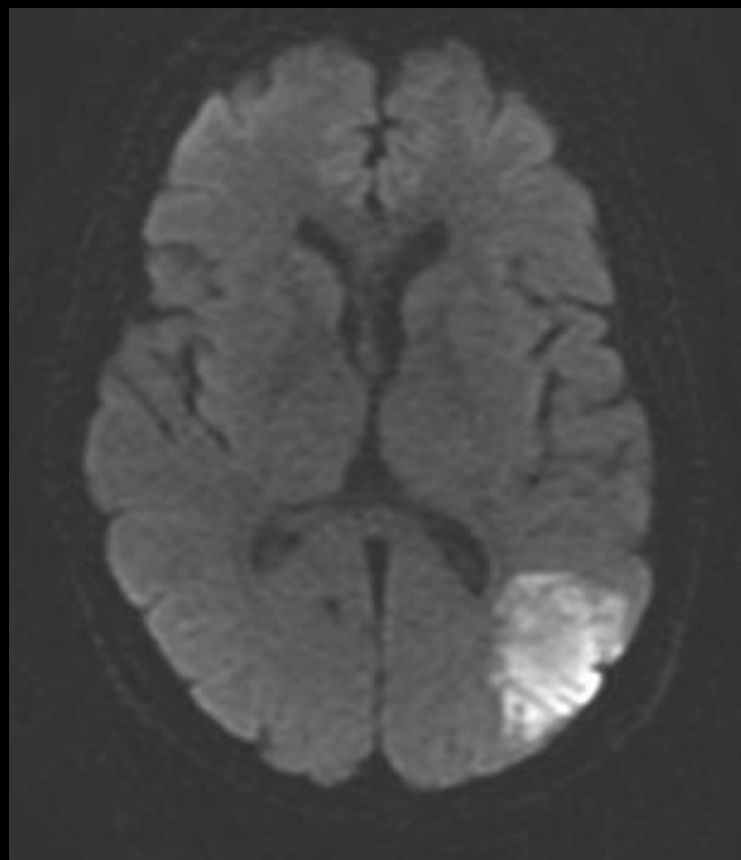
By Jennifer Ligibel, MD¹ | October 12, 2011

¹Department of Adult Oncology, Dana-Farber Cancer Institute, Boston, Massachusetts

Colorectal cancer
Risk 2 -3 X greater in
the obese patient



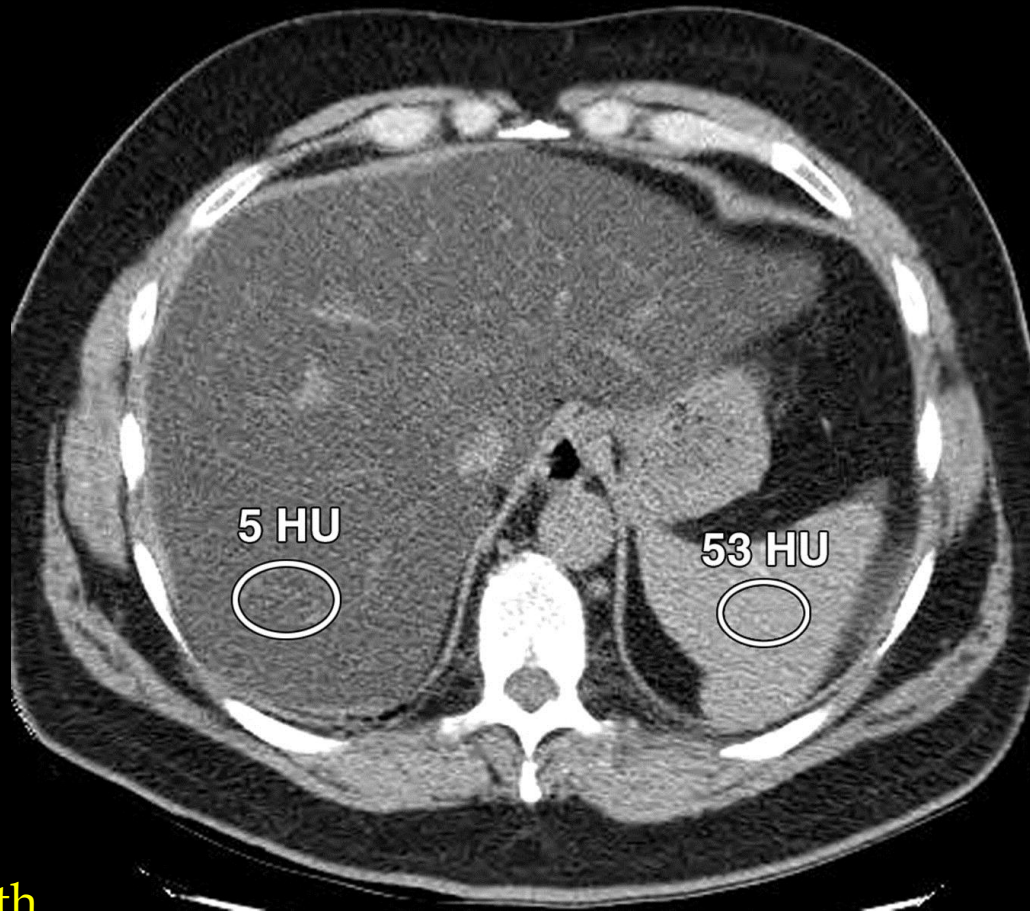
The "fat hormone" leptin may enhance the growth of colonic cancer cells



**Causative factors:
diabetes and hypertension**

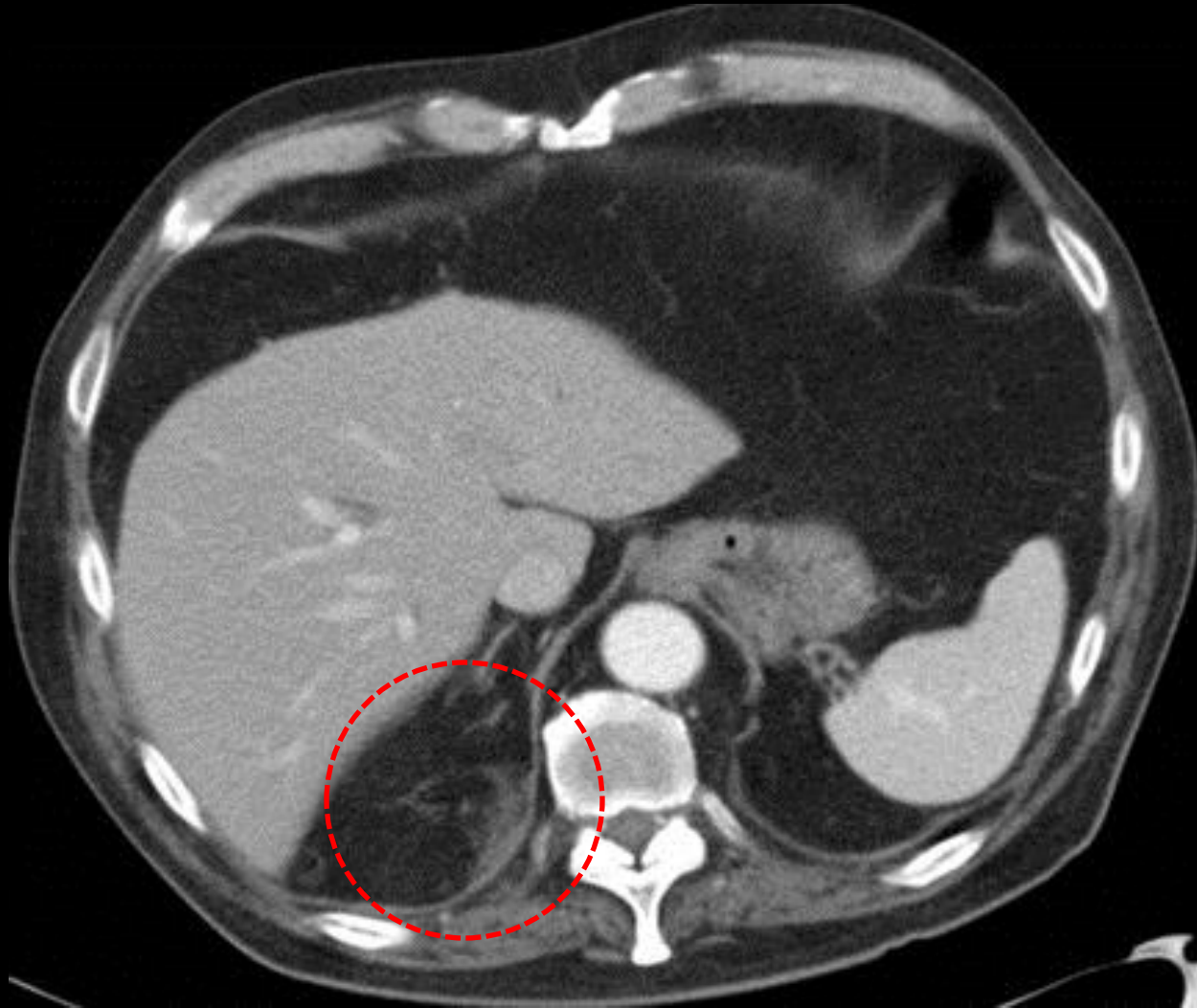
Men with a BMI of 30 or higher were found to be twice as likely to suffer a stroke compared with men who had a BMI of less than 23 (2002 study: Harvard University)

Hepatic Steatosis or non-alcoholic fatty liver disease



Associated with
insulin resistance, elevated TG,
and decreased HDL

Intra-abdominal lipomatosis





Gallstones can be linked to obesity because of elevated cholesterol levels

Objective 3:

Imaging risks for the obese patient

- More radiation required to penetrate tissues
- Poor image quality especially with plain x-ray
- More images required for mammography
- Poor image quality with ultrasound
- Some imaging tests can't be done

In 1989 0.1% of patients had limited quality of radiology reports due to obesity and this rose to 0.19% in 2003 [8].
(A 2 fold increase)

Ultrasound

- a. Ultrasound energy is attenuated by fat tissue.
- b. At 7 MHz, 50% of the beam intensity (watts/cm²) is attenuated per centimeter of fat.
- c. Signal strength drops by 3 decibels (dB). In an obese patient.
- d. With 8 cm of extra-peritoneal fat, only 6% of the original beam intensity enters the peritoneal cavity.

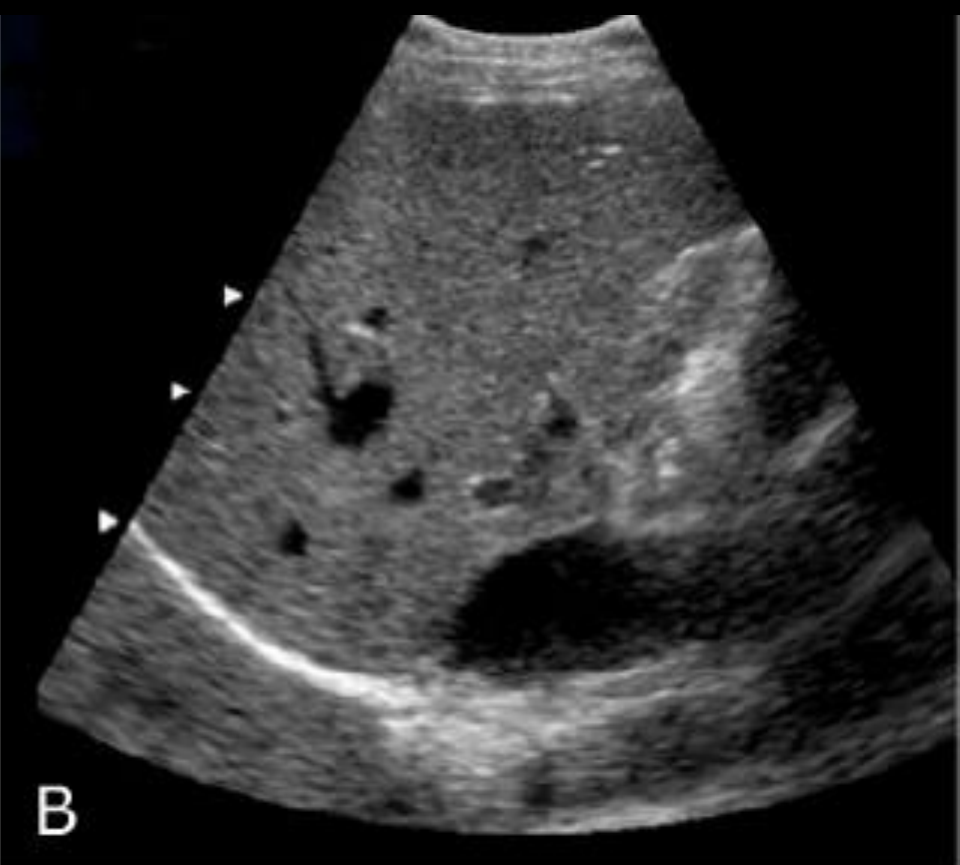
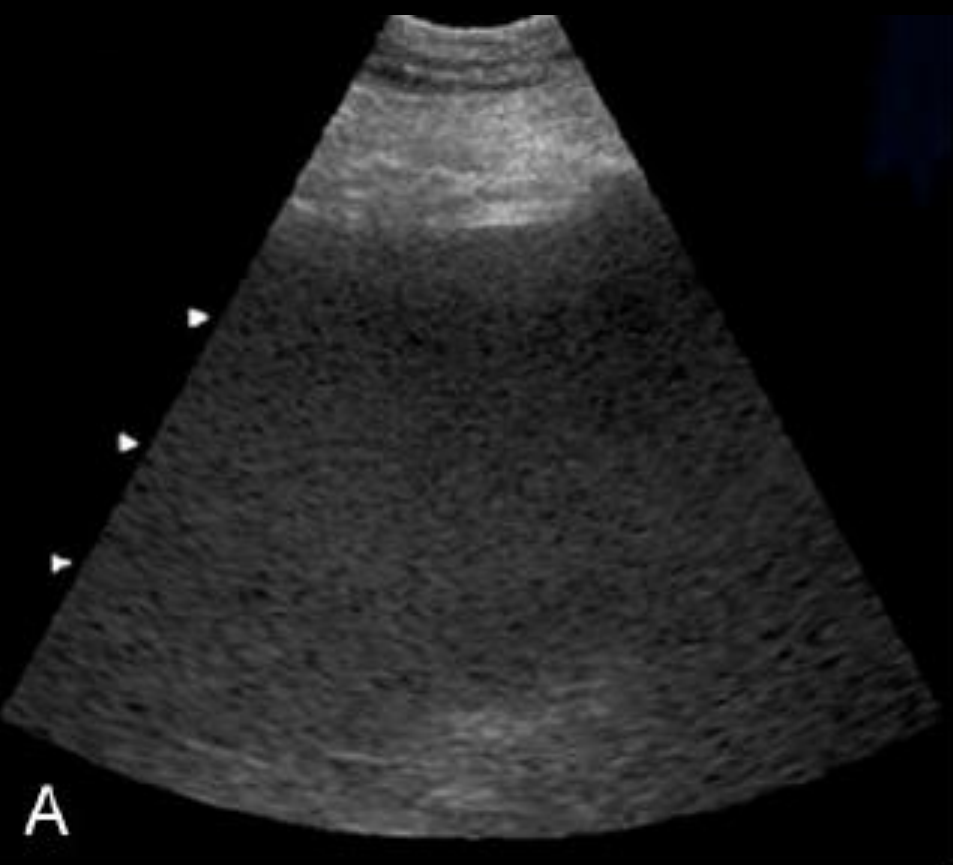


Figure 1. Right upper quadrant ultrasound images in **(A)** a patient weighing 250 lbs and **(B)** a patient weighing 150 lbs. Subcutaneous fat attenuates the ultrasound beam and renders the image uninterpretable.

X-ray

- ▣ Increasing the x-ray tube voltage and current increases the penetration through excess tissue but reduces image contrast.
- ▣ Increasing exposure time can improve image quality, although it can cause motion artifact.
- ▣ Increasing tube current or exposure time increases the radiation dose to the patient.

“In the extremely obese, radiographic examinations of the abdomen can result in effective doses **50 times** greater than those expected for a nonobese individual.”

¹ From the Department of Nuclear Science and Engineering, Massachusetts Institute of Technology, 150 Albany St, NW14-2207, Cambridge, MA 02139 (J.C.Y.); Office of Medical Physics and Radiation Safety, Boston University Medical Center, Boston, Mass (R.H.B.); and BioMed Software, Newton, Mass (J.C.Y., M.J.H., J.H.M.). Received January 23, 2008; revision requested March 17; revision received January 22, 2009; accepted February 4; final version accepted February 9. **Address correspondence to J.C.Y. (e-mail: jcyanch@mit.edu).**

© RSNA, 2009

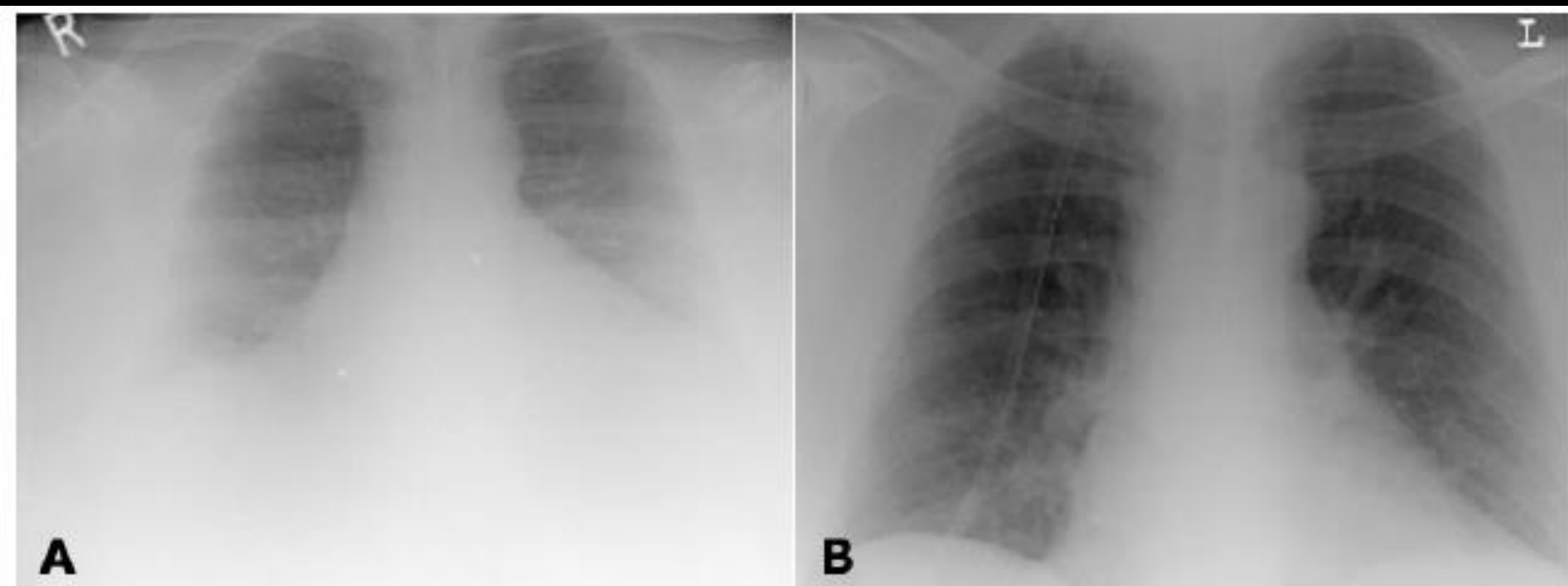


Figure 2. Two chest radiographs in the same patient. **(A)** Fat tissue attenuates the x-ray beam, resulting in a limited quality image using standard methods of image acquisition. **(B)** Increasing the kVp and mAS and using an antiscatter grid can improve the image quality.

X-ray Fluoroscopy

- ▣ “Obese patients are at a higher risk of radiation-induced skin injury because of poor radiation penetration and the accompanying closer proximity of the x-ray source to the patient.
- ▣ Absorbed dose at the entrance skin site in obese patients can be as much as 10 times higher than in some nonobese patients.

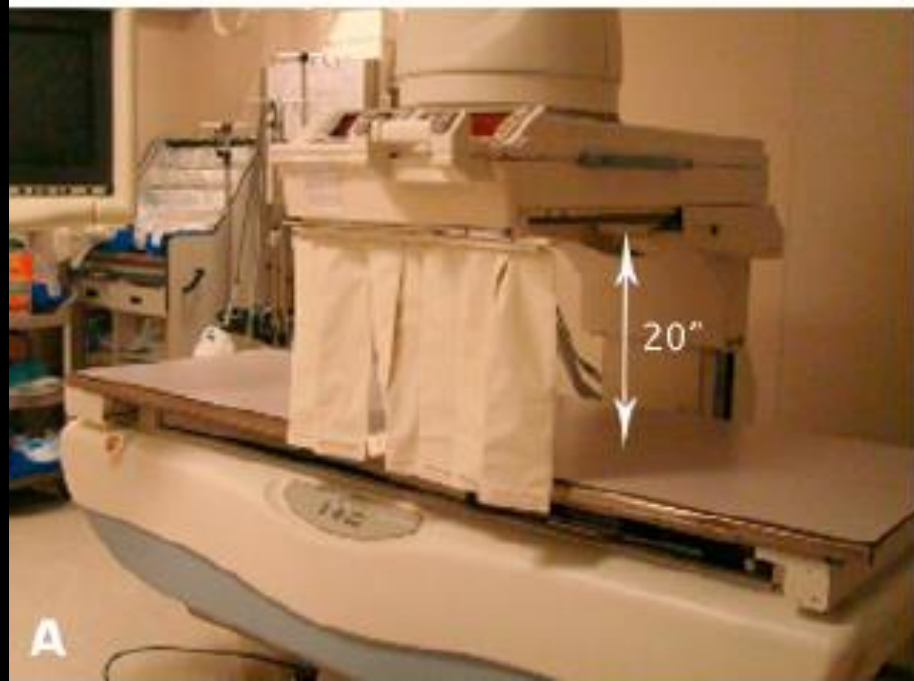


Figure 3. (A) Compare standard fluoroscopy equipment on the left to new **(B)** bariatric scanner on right with larger aperture opening (lines) to accommodate morbidly obese patients.

Mammography

- ▣ Breast tissue is very mobile, large breasts can easily be distorted by twisting or rolling, making it difficult to accurately localize lesions for diagnostic views.
- ▣ Breast folds can be a major problem, and additional views may be necessary to eliminate them.
- ▣ Mosaic or tile imaging may be needed to obtain adequate compression and/or to image all breast tissue.



YES, I DID HAVE MY MAMMOGRAM
TODAY... WHY DO YOU ASK?

Mammography

- ▣ University of Washington School of Medicine (Archives of Internal Medicine)
- ▣ examined findings from 100,000 mammograms
- ▣ found that obese women had a 20% greater risk of a false-positive reading than women who were at normal weight or thin

CT

- ▣ Increasing the tube voltage and current can improve image quality. However it also increases the radiation dose in obese patients.



ImC:No Contrast

CT

“In CT, the scanner output increases by up to twice that used on a thinner patient. However, the effective dose to the obese patient does not double – it is only an increase of 20-40%. This is due to the increased mass of the patient and the self-shielding effect of the subcutaneous fat. Still, as in fluoroscopy, the skin dose to the patient increases dramatically with the higher x-ray tube output.”



Anterior 4038K Duration:1150sec 256x1024
Pic:2.4mm 99m Technetium

Posterior 3787K Duration:1150sec 256x1024
Pic:2.4mm 99m Technetium

Bone scan:
Rule out osteomyelitis

Summary

- ▣ Obesity increases health care costs and can physically harm medical personnel
- ▣ Obesity places the patient at risk for at least 10 serious medical conditions
- ▣ Obesity results in poor diagnostic studies and increased radiation dose to the patient

Thank you