

# ***“Building” the Practice of Routine Gonadal Shielding During Radiography***

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**Disclosures:  
Chair, NCRP SC 4-11  
Chair, Image Gently Alliance**

***The Practice of Routine  
Gonadal Shielding  
During Radiography:***



**Nuts and Bolts**



[https://www.clipartkey.com/view/x/wioJ\\_cartoon-lightning-bolt/](https://www.clipartkey.com/view/x/wioJ_cartoon-lightning-bolt/)

# Outline:

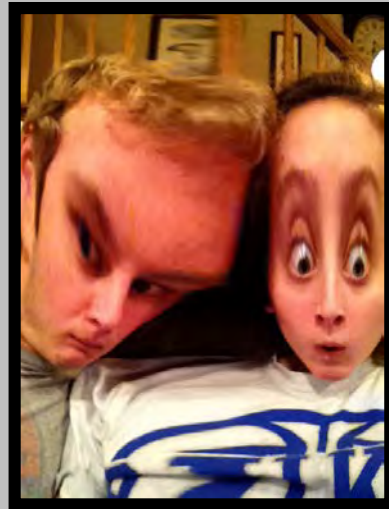
## Radiography and Gonadal Shielding

- Medical radiation (risk) is still relevant
- Radiography is frequent (and *of value*)
- There is evidence for current recommendations
- *Communication is essential*

# Outline:

## Radiography and Gonadal Shielding

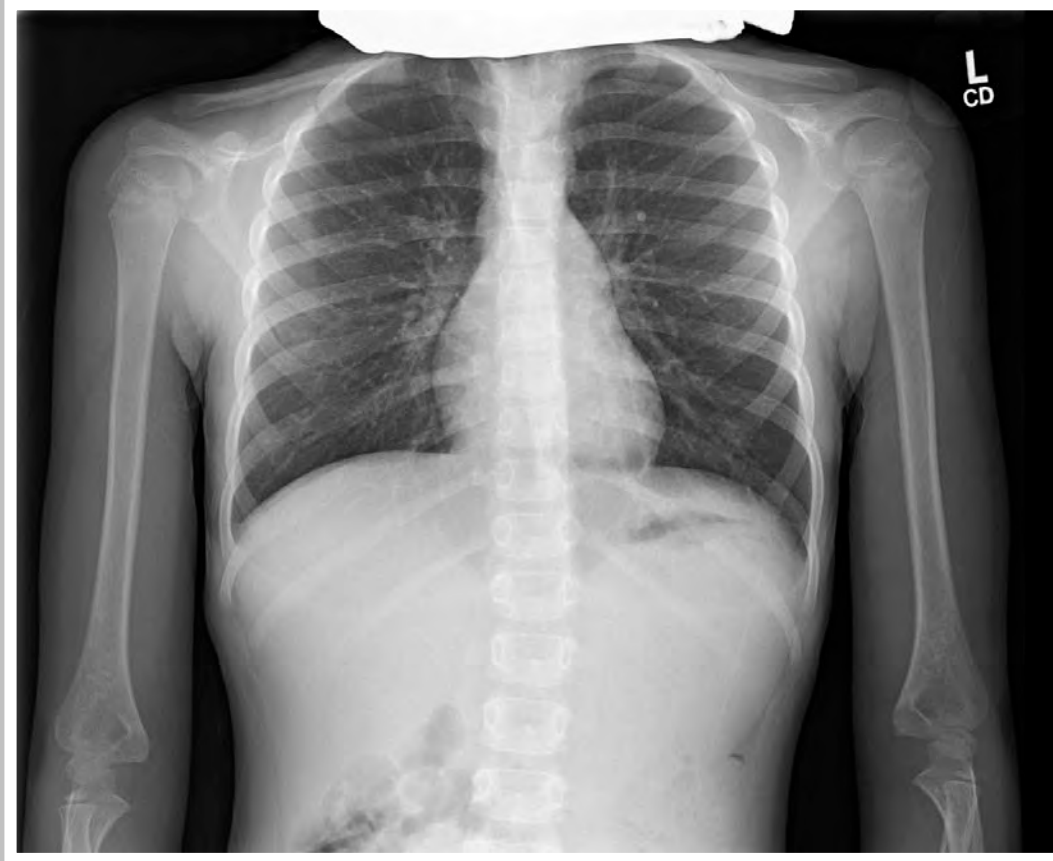
- **Medical radiation (risk) is still relevant**
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- There is evidence for current recommendations
- Communication is essential



***5.5.20: "I am under treatment from a psychiatrist because with this ... I got a guilt syndrome"***

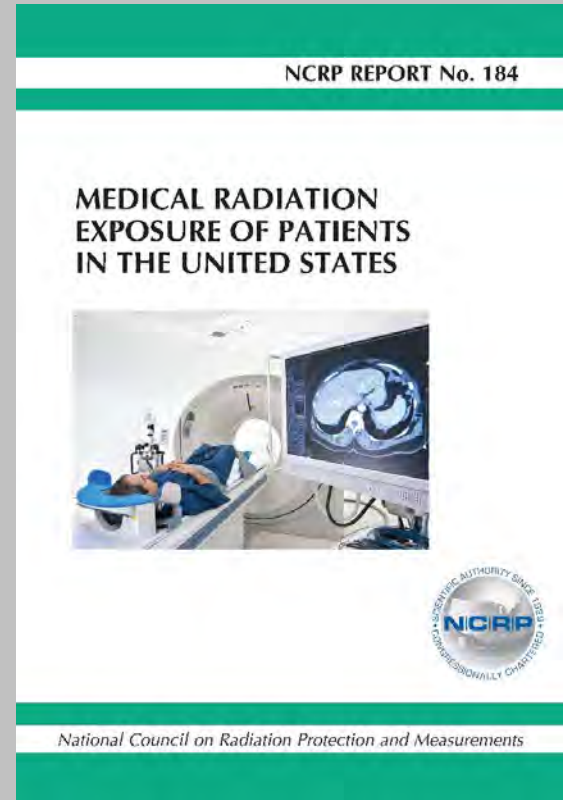
***5.15.20: "I'm still afraid of the consequences of radiations on my children and I'm under treatment from a psychiatric [sic]."***

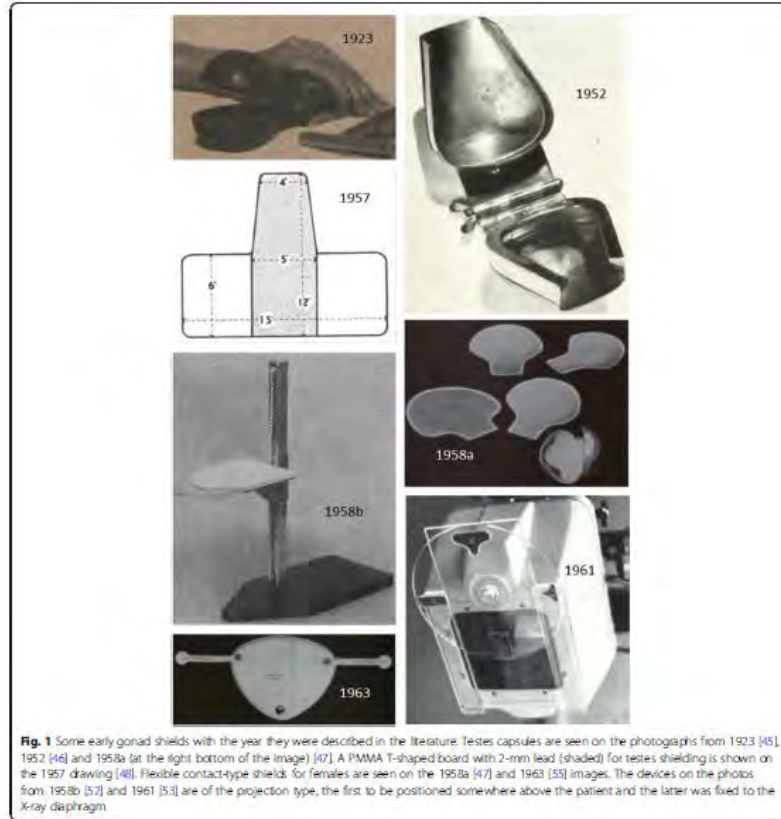
# Mother requested thyroid shield for CXR



# Percentages of ionizing radiation examinations performed (age range up to 18 yrs)

- Radiography **86%**
- CT **9.5%**
- Fluoroscopy **3%**
- Nuclear imaging **1%**
- interventional procedures **0.5%**







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# Some Resources

Growing (body) of literature

Marsh and Silosky  
AJR April 2019

Strauss et al  
JACR Dec 2017



## Patient Shielding in Diagnostic Imaging: Discontinuing a Legacy Practice

Rebecca M. Marsh<sup>1</sup>  
Michael Silosky<sup>2</sup>

**OBJECTIVE.** Patient shielding is standard practice in diagnostic imaging evidence that it provides negligible or no benefit and carries a substantial patient dose and compromising the diagnostic efficacy of an image while the patient shielding is discarded, and the fully of its continued use.

**CONCLUSION.** Although change is difficult, it is reasonable on radiological practices, and radiologists to abandon the practice of patient shielding.

**P**atient shielding is an integral part of radiology. Its practice and importance are so deeply ingrained that when a group of radiologic technologists was recently asked what they would do if their institution adopted a policy to not provide patient shielding, 89% of respondents stated that they would shield patients anyway. One percent of respondents said that such a policy change would cause them to quit their job [1]. This raises an important question: why do we shield patients?

In addition to unnecessary effects, any risk that may lower than that which was in place of the practice before radiation used in radiologic diagnosis due to the breast patient undergoing operations of the patient was not.

The radiation dose inside patient undergoing operations was 1.2 mSv [11]. This had been reduced to approximately 0.01 mSv to the reproductive [12] for a majority 96% from data about to be radiation doses of less than 1 mSv [13]. Multiple that fetal doses from radiologic examinations are not affected at doses of less than 3000 mSv [14]. Consequently, the regulations could only a concern regarding hereditary risks (i.e., mutations in germ cells) that may affect future generations and advanced gonadal shielding only. The wording in the April 2015 version of table 21 of the

**Keywords:** gonadal shielding, patient safety, patient shielding, radiology, shielding

doi:10.12149/AJR.18.2089



Received August 6, 2018; accepted without revision August 10, 2018.

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AJR:18:212-218, 2019

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AJR, 2019, April 2019

RICHARD L. MORIN, PhD, DONALD P. FRUSH, MD

## Reconsidering the Value of Gonadal Shielding During Abdominal/Pelvic Radiography

Keith J. Strauss, MS, Eric L. Giegold, PhD, Donald P. Frush, MD

Shielding the gonads, especially when imaging children with ionizing radiation, has been widely accepted as a good radiologic practice since it was introduced approximately 60 years ago [1,2], when some of the first concerns of radiation dose to the reproductive organs were pointed [3,4]. Less than 10 years ago, some began questioning the value of this "best practice" [5]. In this column we address a few basic questions about the efficacy of gonadal gonadal shielding.

The accurately placed shields reduce the dose received by reproductive organs? A gonadal shield on an adult male patient reduced the dose to the testes during manual pelvic exposures by 36% in a recent study (from 254 to 166 µSv, a savings equal to 8 days of natural background radiation) [6]. The shield reduced the dose from primary gonads, but the majority of the radiation dose is from internal sources in males, unaffected by the shield. Furthermore, as the gap between the shield on the surface of the body and the gonads increases, the ratio of scatter to primary dose to the gonads increases. This reduces the effectiveness of a shield for the testes at a depth below the surface. This problem is compounded by the variance in the actual location of the testes within the abdomen [7]. These data suggest that the effectiveness of the

shield for the ovaries may be less than 20%.

Can a shield be placed accurately over the reproductive organs without interfering with critical anatomy? Anatomic variance in the location of the ovaries does exist, and accurate placement of shields is challenging [7]. However, the testes can be accurately located and shielded, a recent article concluded that the continued shielding of adult male gonads during radiologic imaging of the pelvis remains a best practice [8]. For both genders, the need to reduce an exposure because the shield obtained critical anatomy results in increased dose to the patient.

In gonadal shielding efficacy, when automatic exposure control (AEC) is used? The efficacy of radiography today, except for children younger than 5 years is performed using AEC. The exposure automatically terminates when a predetermined radiation dose is received by sensors in form of the image receptor. This manages the radiation dose to the patient required to provide a good-quality image. If the shadow of gonadal shielding impacts on the AEC sensor to any degree, termination of x-ray that should have resulted the AEC sensor remains. The machine crash by extending the exposure, which increases the radiation dose to the patient. A recent study [9] verified that increases in dose to the stomach or

like dose were as great as any decreases to the reproductive organs.

How informative an reproductive organ? The common opinion among radiation biologists regarding this question has shifted. The risk for hereditary effects in humans, based on animal models because genetic effects in humans have never been observed, is lower than previously believed [10]. The International Commission on Radiological Protection [10], in response, reduced the mass weight factor for the gonads from 0.2 to 0.08 in Publication 103. The weighting factor of the colon, stomach, and bone marrow is currently 0.12 because those abdominal organs are believed to be more radiosensitive than the gonads. Logically, the organs assigned the highest radiosensitivity (highest mass weighting factors)—bone marrow, colon, lung, stomach, and breast—would need to receive priority with respect to shielding.

Is there a psychological benefit from the use of contact gonadal shields for "radiation protection"? Some patients and/or their parents expect to be shielded when imaged. "Peace of mind" was derived from shielding practices during their previous imaging. Those patients may have been told that shielding provides important protection during their examination. This may cause

# Evidence for Current Recommendations

- **Since 1950s origin of recommendations, advances result in dose decrease of up to 95%**
- **Gonads are not as radiosensitive as first thought**
  - Latest assigned radiosensitivity lower by more than 50%
- **“Ideal” shielding seldom achieved**
  - Reports of <50% fully covered even in males
  - Can be difficult with children moving

# Evidence for Current Recommendations

- **With AEC, can increase overall exam dose**
  - To organs in field with relatively higher assigned radiosensitivity
- **For ovaries, much of dose is from scatter unaffected by shield**
- **Can obscure anatomy**
- **Hereditary effects from radiation have not been shown (to be statistically significant) in humans**
- **Hygiene (?)**

# Effectiveness of Gonadal Shields

- Karami et al (Meta-analysis) Arch Iran Med. 2017;20:113-23

Failure to fully cover gonads 52% of the time in males and 85% females

- Bardo et al Pediatr Radiol 2009;39: 253

- 0 - 20% reduction

- Scatter x-rays reach gonads and deliver 80 – 90% of the original dose

- *Varied location of ovaries more than 50% of the time places*

eg

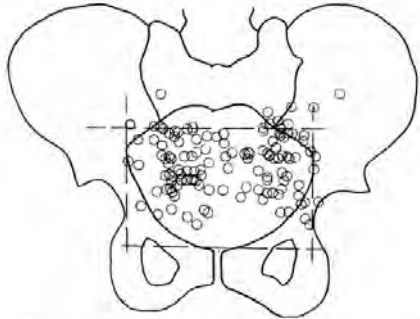
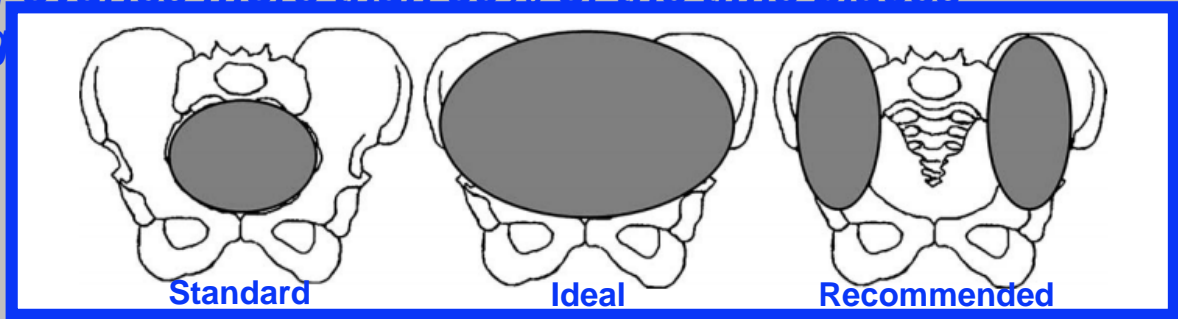


Fig. 1. Schematic representation of pelvis with positions of 128 ovaries plotted. Vertical and horizontal lines used for analysis are included.

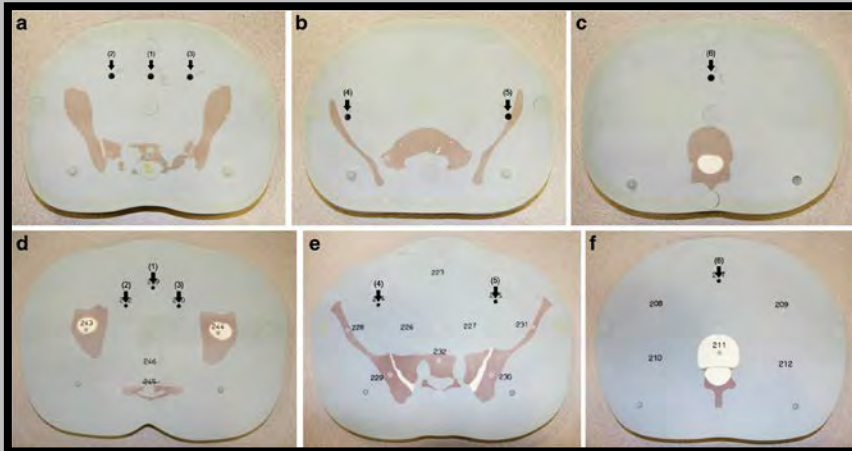


# Automatic Exposure Control

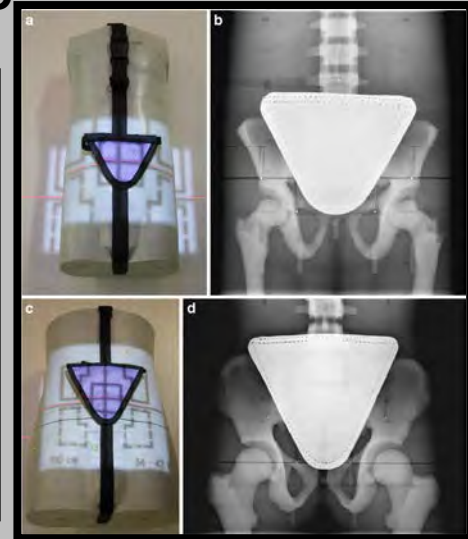
- AEC terminates exposure when target dose received by AEC sensor: valuable and familiar technology
- Not to be used in very small children: use manual/fixed technique

Kaplan et al. *Pediatr Radiol* (2018) 48:227-34. Anthropomorphic phantoms, shielding, AEC

*5 yo*



*Adult*

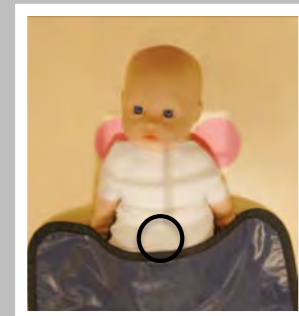
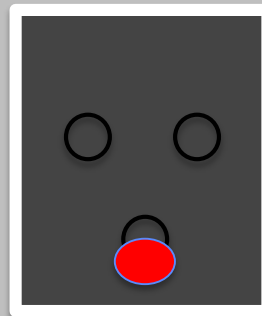


# Automatic Exposure Control

- Gonadal shield shadowing sensor may elevate patient dose<sup>1</sup>
  - Increase dependent on degree of shadowing
  - DAP increased 60% (5 yo) and 147% (adult) anthropomorphic phantoms
  - Colon and stomach organ dose increased 21 – 51% and 17 – 100% in 5 yo and adult, with  
*ICRP weighting factors greater than gonads*
- *“Guidelines state that a female gonadal shield should not be used in conjunction with AEC,...but use of AEC is so ubiquitous and gonadal shielding so error-prone ... that it is likely the two techniques are at times combined.”<sup>1</sup>*

<sup>1</sup>Kaplan et al. *Pediatr Radiol* (2018) 48:227-34

Courtesy Keith Strauss (modified)



Remember: *not prohibition for gonadal shielding...*  
rather a *prescription* when use is warranted. So  
*shielding can be used in some circumstances.*

For example:

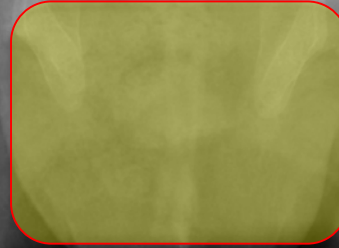
- remote from exposure
- (parental) request that is resonant with practice policy



**R**  
MRG

# Symphysis pubis abnormality

Young boys:  
retractile or high riding testes

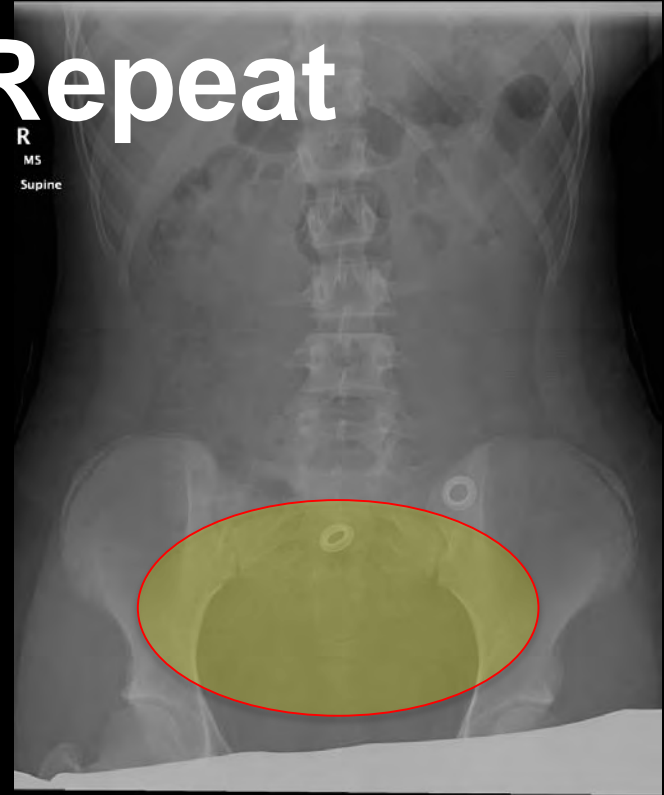


# 13 yo female: abdominal pain.

Moved...



Repeat



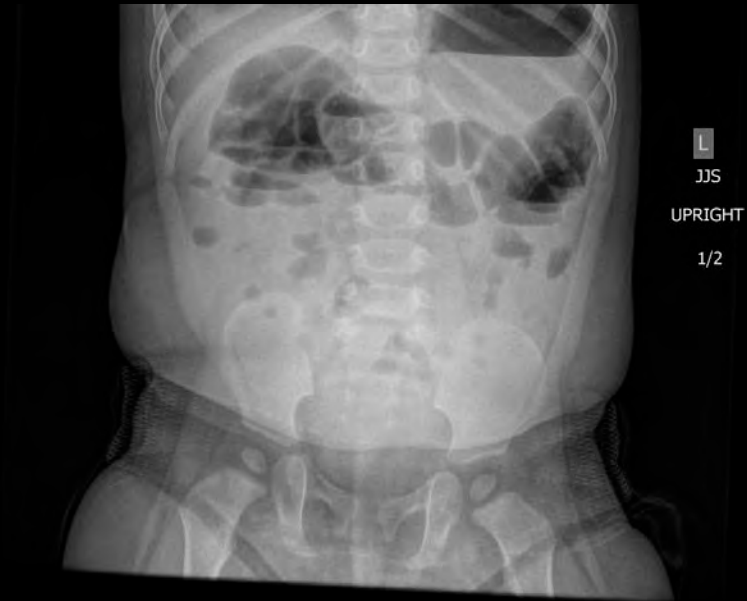
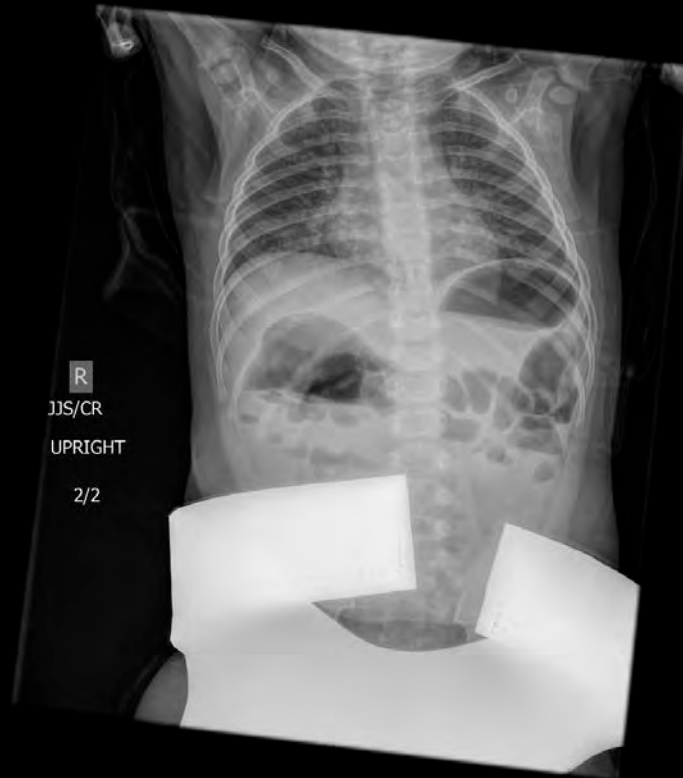
# Gonads shielded?



# Repeated left femur true lateral

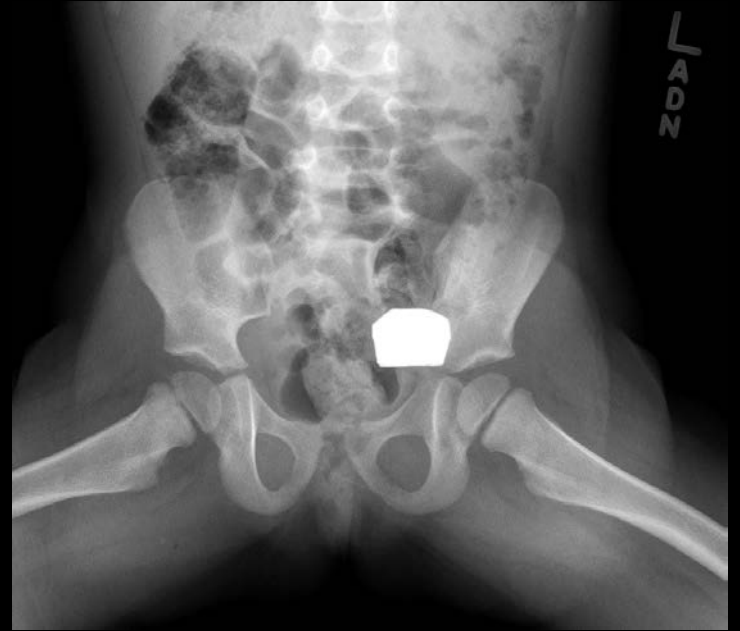
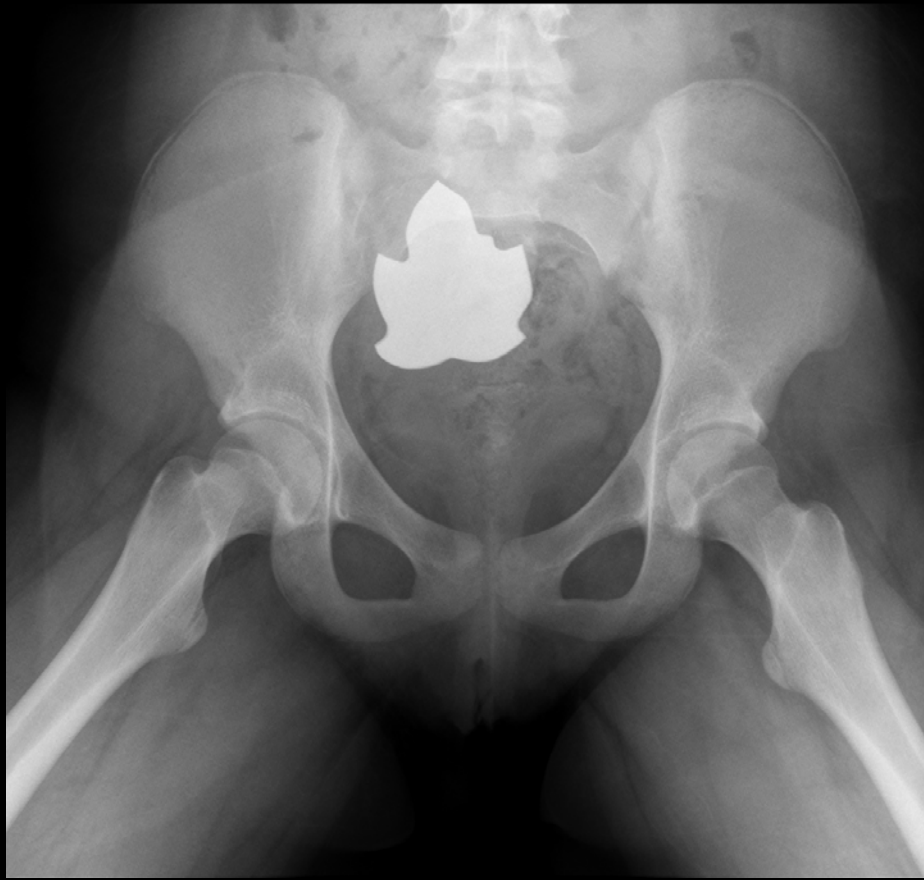


# Upright upper and lower "KUB"



# Supine upper and lower "KUB"



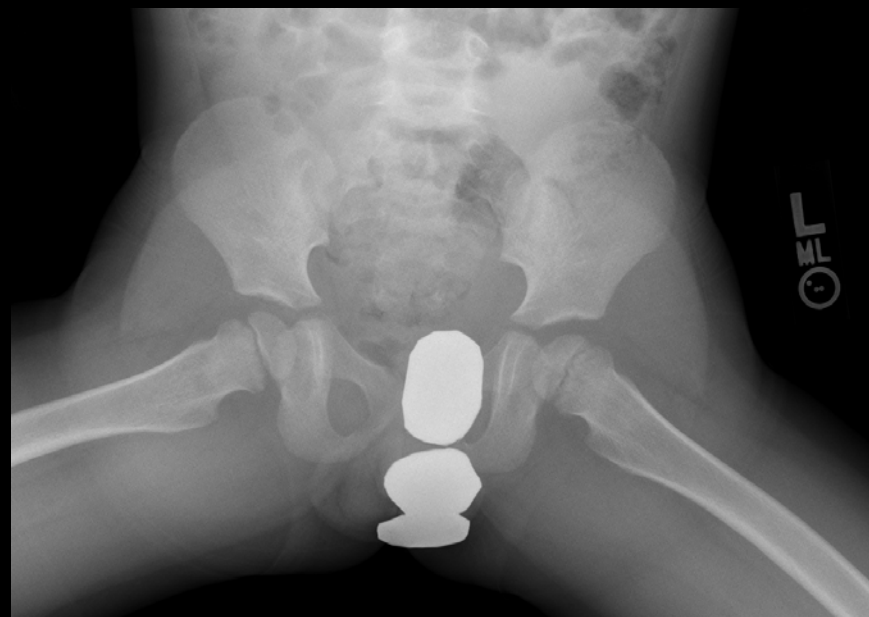
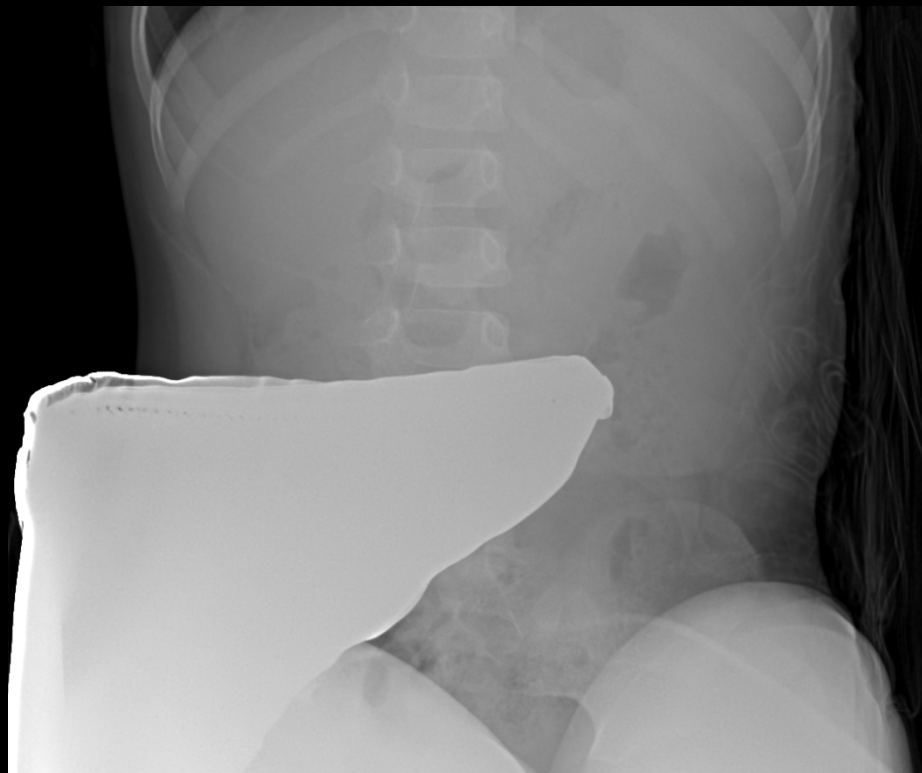


**Courtesy Summer Kaplan, MD CHOP**



**Courtesy Summer Kaplan, MD CHOP**





**Courtesy Summer Kaplan, MD CHOP**

# Frantzen et al. Insights Imaging; 2012: 3:23-32



**Osteomyelitis**

# Some Challenges with Practice Change

- Expectations and traditions
- Why didn't we do this before?
- Why do I need to wear an apron in the room with my child, who now isn't shielded?
- Certification
- Easy to be judgmental and *blame*
- Radiologists are relatively disconnected
- When is diagnostic potential compromised?
- Current regs and guidelines are not always in synchrony with practice