Patient Shielding in Diagnostic Imaging

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Patient Shielding in Radiology

What is the purpose of radiology?

→ Create an image that can be used to help physicians confidently direct patient care.

Benefits should always be greater than the associated risk
Risks and Benefits

1. Compromised image quality & diagnostic information
   - Lead shielding can obscure anatomy of interest
   - Can *increase* dose for AEC exams
   - When anatomy is covered, retakes are sometimes not taken. Often the radiologist must fill in the gaps with information from previous images.¹
   - Increases in dose to the stomach or iliac crest can be as great as any decreases to the reproductive organs.
Gonadal shielding is inconsistent.

Gonadal shielding was often placed incorrectly in pediatric pelvic X-rays (91% of cases in girls, 66% of cases in boys)

*Incorrect placement can lead to a repeated exam.*
Downsides to Patient Shielding?

2. Advances in technology have already lowered patient doses

- Collimation works really, really well
- Very little leakage radiation
- “For organs outside the primary beam, external shielding provides no additional protection.”

<table>
<thead>
<tr>
<th></th>
<th>1953</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organ dose is considerably lower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organ dose</td>
<td>12 mGy</td>
<td>~ 0.5 mGy</td>
</tr>
</tbody>
</table>
Protecting the Gonads?

How are those X-rays getting to the gonads?

Radiologic Technology (2016), 88(2)
Protecting the Gonads?

70 uGy (0.07 mGy)

This may seem like a large reduction in dose when viewed as a percentage, but the absolute dose (both with and without shielding) is biologically insignificant.

A person from Florida taking a 1 week vacation in Colorado
How Much Protection?

Exposure with increasing distance from the X-ray field

Phantom Measurements – Made by yours truly with several inches of PMMA scattering material.
3. Assumed risk is considerably lower

- The risk for hereditary effects in humans is based on animal models because genetic effects in humans have never been observed.

<table>
<thead>
<tr>
<th></th>
<th>1970s</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonads are considered to be less sensitive to radiation than previously thought</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tissue weighting factor</td>
<td>20%</td>
<td>8%</td>
</tr>
</tbody>
</table>
How much radiation exposure does it take to cause sterility?

<table>
<thead>
<tr>
<th></th>
<th>Acute Organ Dose (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temporary</td>
</tr>
<tr>
<td>men</td>
<td>100</td>
</tr>
<tr>
<td>women</td>
<td>1500</td>
</tr>
</tbody>
</table>

0.07 mGy

CONSIDERING A FAMILY?
4. Public perception is important

Christopher Custodio 7 months ago

godbless you im so scared during my pregnancy now because i took an xray when i was a 2months pregnant

A Zha'kia 2 months ago

I and 6 weeks preg before I took a positive preg test , I had X-rays done a an orthodontics office and they did not use a lead jacket . I'm afraid and my anxiety is a little over the roof. What kind of damage could be done at this point 😞
“Technologists are responsible for determining the need for additional radiation safety actions before a radiation exposure.”
Current Guidance

Best Practices in Digital Radiography

“A best practice in digital radiography is the use of lead shielding for anatomic parts that are adjacent to the X-ray field.”

“At a minimum, a patient’s gonads should be shielded when within 5cm of the edge of a properly collimated beam.”
Downsides to Patient Shielding?

“Gonad shielding has served its purpose in times when doses were high. Now it appears that its potential advantages are outweighed by the drawback.”

“The findings suggest that accepted pelvic shielding protocols are ineffective. Consideration should be given to alternative protocols or abandonment of this practice.”
Patients (and their parents)

“External shielding may provide “peace of mind” to the patient or their parents. Patient or operator preference should dictate use of patient external shielding during the procedure on a case-by-case basis.”
Proposed Guidelines

• No patient shielding
  • Allows for technologist discretion

• Development of educational modules
  • X-ray techs
  • Radiologists

• Public outreach
  • Patients & parents
While the use of lead shielding may have reduced patient dose by a small amount, proper collimation and a more appropriate kV would have been even more effective.
3 year old
Exam: Left femur

This lead shield completely obscures the femoral head.
2 week old female
7yo
Exam: Femur
3 month old

AP: 85kV; 0.96mAs
Lat: 75kV; 2.4mAs

- Decrease in image contrast
- Increase in patient dose

<table>
<thead>
<tr>
<th>Chest supine 110 cm</th>
<th>63/1.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest lateral supine 110 cm</td>
<td>70/1.6</td>
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</table>
24 year old patient
3rd trimester pregnancy
23yo female; left anterior 8\textsuperscript{th} rib pain and tenderness
15 yo
Discussion