Radiation Dose And The Use Of Bismuth Shielding In Scoliosis Imaging
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Imaging
"Research indicates an increased risk of childhood acute lymphocytic leukaemia in plain film studies and an increased risk of fatal breast cancer from scoliosis series. The linear, no-threshold model, which states that no level of radiation exposure is without consequence, is currently the best estimate of risk. The younger the patient at the time of exposure, the greater the risk of developing a fatal cancer."
Radiology February 2005

U.S. National Cancer Institute
- Retrospective study
- 5,466 women with scoliosis
- Average of 24.7 x-rays prior to 1976
- 70% higher chance of developing breast cancer
- Radiation exposure is proportional to an increased cancer risk
- Full spine dose 1940 to 1959 6-200 times higher than today
- ALARA principle should always be followed

Study Aims
- Multi-stage study commenced in April 2005
- To identify the modality with the lowest recorded skin entry and exit doses
- To standardise the imaging performed
- Evaluate the effectiveness of bismuth shielding

Bismuth
- Heavy Metal
- Chemical Symbol Bi
- Atomic Number 83
- Causes beam hardening and therefore decreases absorbed radiation dose
- Radiolucent

Breast Shields
- Commercially available bismuth shields
- RCH current protocol does not use breast shields
- Copper shielding used in chiropractic spine imagining
- Bismuth more flexible and user friendly
- No research available on bismuth use in general imaging
Method

- Philips general room with AGFA CR Full Leg/Full Spine cassette holder with a 1.5m FFD
- Philips Digital Diagnost DR room with a fixed 2.4m FFD
- Philips MD Eleva Fluoroscopy room on High Quality mode with a fixed 1.25m FFD

Method

- 85 kg Alderson Rando Anthropomorphic phantom
- Tape placed at Thyroid, Breast and Symphysis
- PTW Diados Dosimeter used
- Pilot test showed no variation in exposures within each modality

Method

- 5 exposures for each level
  - No shielding
  - Lead shielding
  - Bismuth shielding
- Shielding placed on posterior surface
- Phantom positioned PA erect
- 4ply sheet of bismuth
- 0.06mm lead equivalent

Bismuth shielding reduced doses by:

- Skin entrance dose
  - Thyroid 40%
  - Breast 50%
  - Gonads 20%
- Skin exit dose
  - Thyroid 15%
  - Breast 30%
  - Gonads 20%

Skin Entry Dose - Bismuth

Skin Exit Dose - Bismuth
Overall Dose - Bismuth

**Total Dose**

- CR Skin Entry
- DR Skin Entry
- Fluoro Skin Entry
- CR Skin Exit
- DR Skin Exit
- Fluoro Skin Exit

Dose measurements

- **Total skin entry**
- **Total skin exit**

Images from each room

- DR
- Fluoroscopy
- CR

Limitations of Study

- Measurements were recorded for a small area only.
- Image quality has not been measured accurately.
- The phantom is the equivalent of an 85kg adult.

The Future

- Orthopaedic surgeons happy with bismuth shielding
- Discussions with bismuth manufacturers
- Further work with equipment specialists to optimize image processing
- Further studies on the use of Bismuth shielding in general examinations

References

- Mayo Clinic. Scoliosis. *www.mayoclinic.com*
References