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A re-evaluation of the use of gonad shields for patient x-ray examinations

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Introduction

The use of gonad shields has hitherto been advised for all follow-up x-rays of the pelvic region; however, a growing body of evidence suggests that gonad shields may no longer be appropriate for female patients[1-4]. Reasons include:

- A large reduction in x-ray doses since the 1950s;
- Re-appraisal of radiological risk with successive reductions in the ICRP gonad organ weighting factor;
- Radiographic audits indicating poor shield placement;
- Excess dose from retakes due to misplaced shields; and
- Uncertainty in ovary position.

This study investigated the efficacy and suitability of gonad shields with an emphasis on female patients.

Methods

Gonad doses in adult and paediatric sized anthropomorphic phantoms (CIRS, USA) were measured using TLDs during radiographic exposures of the pelvis and abdomen, both with and without shielding. The results from the phantom studies were used to validate the use of a subtractive shielding model (Figure 1) in PC X-ray Monte Carlo (PCXMC), a dose calculation program for the estimation of the doses (STUK, Finland).

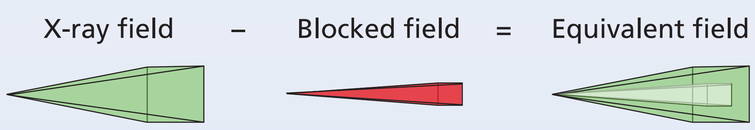


Figure 1: PCXMC Shielding Model

Following good agreement between phantom and simulated measurements, radiographic examinations of the abdomen, pelvis, lumbar spine & SI joints were simulated in PCXMC. For each standard numerical phantom (0, 1, 5, 10, 15 year old & adult), the shield size and position were adjusted to reflect the pelvic anatomy.

Due to the large number of abdominal and whole trunk x-rays carried out on neonatal wards, gonad shielding was modelled for a range of preterm and infant sized phantoms.

The effect of inappropriate shielding was also considered; modelling unsuitable shield sizes as well as shield misplacements.

Results

The use of a King's Lynn type gonad shield was found to give up to 95% reduction in dose for male patients, with no obscuration of bony anatomy. For female patients, dose savings up to 60% were achieved, but only at the cost of compromising bony anatomy. The results were similar for all patient ages.

For patients with ovaries in a superior or lateral position, a 'correctly' placed shield over the pelvic basin reduced dose by only a small fraction (17%). Shield misplacements of just 5 cm laterally or inferiorly could result in ovary dose savings of just 5%, whilst compromising image quality (Figure 2).

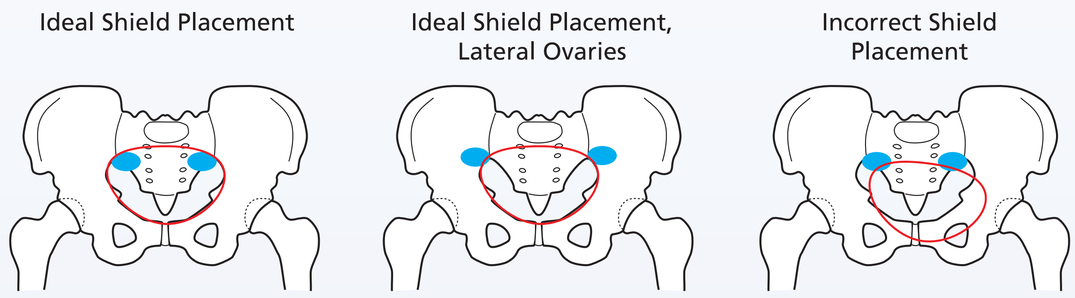
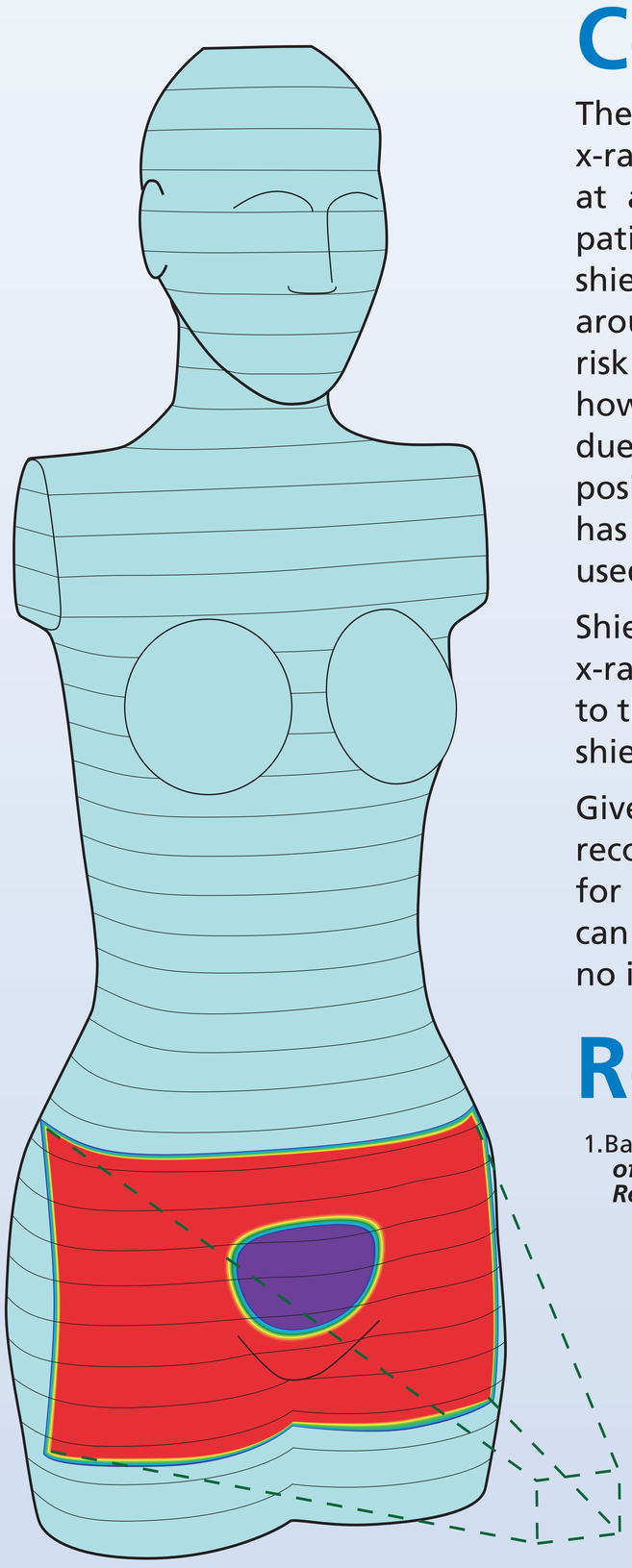


Figure 2: Relative shield and ovary positioning

The dose burden of retakes due to bad positioning was calculated using data from radiography audits and simulated dose savings. The results predict that for a retake rate of just over 16%, population dose savings are not achieved.



Conclusions

The effective dose to an adult female from a pelvic x-ray is of the order of 0.26 mSv, with ovarian dose at approximately 0.6 mGy. Doses for paediatric patients are considerably lower. Even with optimal shielding, the effective dose is only reduced to around 0.2 mSv.; equivalent to a reduction in the risk of cancer detriment of about 4×10^{-6}. In practice however, such dose and risk savings are much lower due to shield misplacement and variability in ovarian positioning. Gonad shielding for paediatric x-rays has even smaller risk benefits due to the lower doses used.

Shield use is also associated with an increased risk of x-ray retakes due to obscuration of bony anatomy to the extent that population dose savings through shield use may not be realised.

Given the low level of dose for these x-ray types, we recommend that gonad shields should not be used for female patients; although male-specific shields can be used for a high degree of dose saving with no image detriment.

References

1. Bardo, D. M., Black, M., Schenk, K. and Zaritzky, M. F. (2009), "***Location of the Ovaries in Girls from Newborn to 18 Years of Age: Reconsidering Ovarian Shielding***", *Pediatric Radiology* **39**(3), 253-259.

2. Liakos, P., Schoenecker, P. L., Lyons, D. and Gordon, J. E. (2001), ***"Evaluation of the Efficacy of Pelvic Shielding in Preadolescent Girls"***, *Journal of Paediatric Orthopaedics* **21**, 433-435.

3. Frantzen, M. J., Robben, S. G. F., Postma, A. A., Zoetelief, J., Wildberger, J. E. and Kemerink, G. J. (2011), ***"Gonad Shielding in Paediatric Pelvic X-rays: disadvantages prevail over benefit"***, *Insights into Imaging* **3**(1) 23-32.

4. Fawcett, S. L. and Barter, S. J. (2009), "***The Use of Gonad Shielding in Paediatric Hip and Pelvis Radiographs***", *The British Journal of Radiology* **82**(977), 363-370.