Gonad shielding in pediatric pelvic and hip radiography: from operator awareness to correct shielding placement

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Aims and objectives

Radiography of the pelvis and hip is commonly performed in assessing hip pathologies in pediatrics. The European Directive on health protection identifies children as a special practice that merit particular attention from the radiation protection point of view, mainly due to the increased radiosensitivities of tissues and lifetime risk for carcinogenesis in the pediatric group.

Radiation protection during radiography of the pelvis has always been portrayed as challenging due to the location of the gonads. It is the professional responsibility of the radiographer to ensure that and optimise the examination for each individual patient. Existing guidelines such as the International Commission on Radiological Protection (ICRP) state that good radiographic technique includes the standard use of protective shielding without obscuring essential diagnostic information, and gonads should be protected whenever it is possible and lie within 5cm of the primary beam.

We conducted this study in an attempt to evaluate the compliance of using gonad protection in pediatric patients when performing pelvic and hip radiographs in our hospital, Queen Mary Hospital, which is a tertiary referral center in Hong Kong, and whether the gonad shield was appropriately placed.
Methods and materials

Retrospective data collection of all pelvic, hip and scoliosis radiography performed in our hospital from September 2017 to March 2018, for patients under 18 years of age are included. Radiographs performed as part of major trauma series are excluded from the study.

Using the ICRP publication 121: Radiological Protection in Paediatric Diagnostic and Interventional Radiology as the reference standard, the radiographs were reviewed by a paediatric radiologist. For each examination, the image is assessed to determine 1) the presence or absence of gonad protection, and 2) whether the protection was placed correctly (Figure 1):

1. The protection should not obscure any bony anatomy
2. Shielding of gonads was considered adequate if the area covered by the shield protects the traditionally expected location of reproductive organs. In males, this was defined as covering the soft tissue margins of the scrotum inferiorly to the symphysis pubis. In females, the pelvic basin was used as popular gonad shield designs presume the ovaries to lie within the pelvic basin. Shielding 100% of the pelvic basin without obstructing any bony anatomy would require unrealistically tight precision of shield placement. Therefore a subjective estimate was made and coverage was deemed adequate if about 90% of the pelvic basin was protected.
3. For scoliosis imaging performed to assess curve progression, shielding of gonads was considered adequate in female patients if 90% of the pelvic basin was protected, even though partially the lower pelvic bone including pubic symphysis may be obscured, since these bony anatomy are not essential for follow up curve assessment. The criteria for male scoliosis radiography remains the same as (2).

Our target is at least 90% of cases with gonad protection present, with at least 90% of these cases showed correct placement of protection. In case these targets were not met during the period, we analyzed the underlying reasons and implemented changes, in hopes to improve the performance in the re-audit cycle, which was conducted in June 2018 to September 2018.
Fig. 1: Examples of radiographs with correct and incorrect placements of gonad protections in male and female patients. (a) Correct placement in male patient. (b) Incorrect placement in male patient with shield positioned too low. (c) Correct placement in female patient for follow up of scoliosis curve progression. (d) Incorrect placement in female patient with shield used too large in size and positioned too high.

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Results

Total 158 examinations were included from September 2017 to March 2018 (Phase I). Gonad protection were only present in 27.2% (43/158), with overall accuracy of placement of 51.2% (22/43). In view of the unsatisfactory performance, changes were implemented (to be discussed below). The re-audit phase (Phase II) was conducted in June 2018 to September 2018, including total 111 examinations. Gonad protection were used in 60.4% (67/111), which showed significant interval improvement compared to previous phase, though overall correct placement rate remained similar at 55.2%. Details of results are listed in Table 1 and Figure 2, with key results summarized as below:

- After evaluation with radiographers, we believe that the most significant contributing factor for our low compliance of using gonad protection in pediatric patients is the lack of awareness among the radiographers. Uncooperative patients or difficult patient positioning is another common reason. Radiographers may also find localization of gonads challenging, especially for female patients, thereby intentionally omit shielding more often in female patients for fear of obscuring bony anatomy, and subsequently lead to repeat examination and resultant increased radiation exposure.

- The overall presence of gonad protection on radiographs has increased from 27.2% in phase I to 60.4% in Phase II. Although both did not meet our target percentage, such increase in compliance is still statistically significant (p<0.01). In both phases, it is demonstrated that gonad protection were used in more frequently in male patients than in female patients (p<0.01).

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- Besides, it is observed that the compliance on gonad protection for male patients has reached 89.1% in phase II (versus 52.0% in phase I), which is very close to our target percentage. We therefore foresee that with further training and continuous reminder to radiographers, we may be able to achieve our target percentage for male patients in the near future.

- When assessing the subgroup of patients with gonad protection correctly placed, it was observed that they are of an older age group than the subgroup without gonad protection (10.2 years old vs 4.3 years old for boys, p=0.02; 15.0 years old vs 9.1 years old for girls, p=0.03; Table 1), such results helped to reveal the potential area and population that needs further effort and improvement.
<table>
<thead>
<tr>
<th>Gender</th>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Mean (95% CI)</td>
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<tr>
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<td>Range</td>
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<tr>
<td>Incorrectly placed</td>
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<td>Median = 15</td>
</tr>
<tr>
<td>Correctly placed</td>
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<td>Median = 5</td>
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<tr>
<td>Not placed</td>
<td>79</td>
<td>8.9 (7.6-10.2)</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>Range</td>
</tr>
<tr>
<td>Incorrectly placed</td>
<td>19</td>
<td>7.6 (5.3-9.9)</td>
</tr>
<tr>
<td>Correctly placed</td>
<td>21</td>
<td>11.1 (8.8-13.3)</td>
</tr>
<tr>
<td>Not placed</td>
<td>35</td>
<td>6.9 (4.7-9.1)</td>
</tr>
</tbody>
</table>

**Table 1:** Subgroup analysis of phase I and II results with reference to gender and age
Fig. 1: Examples of radiographs with correct and incorrect placements of gonad protections in male and female patients. (a) Correct placement in male patient. (b) Incorrect placement in male patient with shield positioned too low. (c) Correct placement in female patient for follow up of scoliosis curve progression. (d) Incorrect placement in female patient with shield used too large in size and positioned too high.

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Fig. 2: Use of gonad protection in phase I and II in male and female patients respectively. Numbers stated on bars represent the number of examinations in each category.

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Conclusion

The re-audit after implementation of changes to raise awareness and compliance among radiographers have significantly increased the use of gonad protection in pediatric population, even though results in phase II did not meet our pre-set target. Further improvement can be anticipated upon further education and reinforcement of the guidelines and recommendations in the future.
References


