Audit

Study on the use of gonadal protection shields during paediatric pelvic X-rays

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Background: There are national guidelines issued by all hospital radiology departments concerning the use of gonadal protection shields for taking X-rays of the pelvis. It is important to follow these guidelines especially when paediatric X-rays are taken. Gonads are very susceptible to radiation as they fall directly in the line of radiation exposure when pelvic X-rays are taken.

Aim: To examine whether these guidelines were being followed.

Methods: This audit considered 355 radiographs taken in a 6-month period on 149 patients, under the age of 16 years, attending the orthopaedic department at King's Mill Hospital.

Results: In only 23% of the cases studied, the correct use of gonad protection shields had been performed. In 67% of the unprotected patients, the shields were not used at all. In the remainder, the shield was incorrectly applied. Out of all the patients, 45% had more than one X-ray thus exposing the gonads to unnecessary radiation. In addition, 8% of patients had a CT scan, 6% had fluoroscopy and 42% had radiographs of other regions of the body.

Conclusions: Guidelines should be adhered to as far as possible and efforts always be made to decrease radiation exposure. Application of the current guidelines excludes the first X-ray exposure of the female pelvis and of the pelvis of trauma patients from the use of shields, thus adding to the number of the X-rays done without protection.

Key words: X-ray – Gonad – Paediatrics

Radiological examination of the pelvis is a common investigation in children, in which a large portion of the trunk is irradiated. The tissues exposed to radiation contain many of the most sensitive organs. There is a wealth of evidence that radiation from X-rays causes direct gonadal damage and mutation. Various studies have been carried out using thermoluminescent dosimeters (TLDs) to measure the absorbed dose in children both in the body and in the gonads during various types of radiological examination. The entrance surface dose for single exposure

varies from 0.26 mGy to 2.89 mGy¹ for pelvic examination depending upon the body size of the patient. The total amount of radiation absorbed increases markedly when multiple X-rays are done: it also rises sharply when CT scans² and fluoroscopic studies are undertaken in these patients, whether of the pelvis or other regions of the body.³ Accordingly, it has been proposed that gonad protection be carried out during all radiographic examinations.⁴

The guidelines specify that gonad protection be used wherever possible. However, in our hospital, the guidelines

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Table 1 Common conditions for which pelvic X-rays are taken in paediatric patients

Diagnosis	Number of X-rays
DDH/CDH	57
SUFE	28
Perthes	47
Trauma	10
Others	20
Normal X-rays	193

Figure 1 Correct placement of shield in male patient. **Figure 2** Incorrect placement of shield in male patient.*Table 2 Number of patients and X-rays reviewed*

Patient factors	Total
Total number of patients	151
Patients reviewed	149
Total X-rays	355
Eligible X-rays (for study)	267
Average X-rays per patient	2.4
Maximum X-rays per patient	20
Patients with multiple X-rays	67

exclude the first pelvic X-ray of a trauma patient and first X-ray of the female pelvis. The purpose of this study was to see if these guidelines were being followed. The radiology department of this hospital, on an average, takes about 400 pelvic X-rays of paediatric patients every year for the orthopaedic department. The indications include painful hips, stiffness, limp, trauma, *etc.*

Patients and Methods

This study included all pelvic X-rays of the paediatric patients aged 3 months to 16 years who were referred by the orthopaedic department of King's Mill Medical Centre for at least one X-ray in a 6-month period from October 2000 to March 2001 (Table 1). All X-rays were reviewed by a single person for consistency. In all, 151 patients were referred for pelvic X-rays. Of these, X-rays of 149 patients were made available to us for the study. These patients had 355 pelvic X-rays taken (Table 2); 72 patients were male and 77 female.

All female patients and trauma patients had their first pelvic X-ray excluded from this study since guidelines permit these X-rays to be taken unshielded. As such, 101 patients with 267 X-rays qualified to be included in this audit. A proforma was completed for every patient whose X-rays were reviewed.

Figure 3 Incorrect placement of shield in female patient.

Table 3 Protection rate of gonads

Number	Correct	Incorrect	No shield (unprotected)
Patients	23 (22.8%)	26 (25.8%)	52 (51.4%)
X-rays	81 (30.3%)	29 (10.6%)	157 (58.8%)

In addition to the technical details, the indication and the diagnosis were noted from the referral cards and from the report attached to the folder. Any other radiological investigation, especially CT scan, fluoroscopy, or X-rays of the other regions of the body, if carried out on the patient, were also noted. The presence or absence of gonad protection shields was recorded. A note of correct or incorrect placement of the shields was made (Figs 1–3). According to the protocol, the shields should be placed above the pubic symphysis in females and below the pubic arch, directly over the testicles, in males. The total number of films taken were noted.

Of patients, 45% had more than one pelvic radiograph taken. In addition, 8% of patients had CT scan, 6% had fluoroscopy and 42% had X-rays of the other regions of their body.

Results

On average, 2.4 X-rays were carried out per patient. Nineteen patients had more than 5 pelvic X-rays taken and 82 patients had one pelvic X-ray taken. It was found that only 23 (23%) of patients had adequate protection of the gonads while taking the radiographs. Of the unprotected patients, in 67% of cases the shield was not applied at all (Table 3); in the rest, the shields were placed at the wrong site thus exposing the gonads to unnecessary radiation. Overall there were 78 (77%) unprotected patients and 186 (70%) unprotected X-rays.

Discussion

The National Radiological Protection Board (NRPB) guidance notes state that gonad protection should be carried out wherever possible and ideally in all radiological procedures. This is most important in those patients who are directly exposed to radiation such as pelvis X-ray examination.

The advantage to the patient in having a diagnostic radiographic examination should far outweigh the associated radiation hazard. It is, however, important to implement all the rules of radiation protection. The effects of exposure to the ionising radiation can be 2-fold: (i) somatic, where the patient is affected; and (ii) genetic,

where following generations are at risk. The irradiation of gonads can cause gene mutations in reproductive cells, which may only become evident in the patient's offspring, though the risk involved is low.⁶ Recommendations on allowable dose limits and effective dose⁸ are continually being updated through research and audits and it is the responsibility of radiographers to keep levels of radiation exposure to the minimum.

Various methods⁷ have been used for the estimation of the absorbed dose in various organs in the body, though it is difficult to estimate the exact dose. For boys, entrance surface dose is taken to be the mean absorbed dose to the gonads,¹ but it is different in girls.

Our study shows that strict adherence to guidelines needs to be monitored to achieve the required level of protection from unnecessary radiation. Although the amount of radiation absorbed in the body is small in the case of a single X-ray, the cumulative effect of multiple X-rays can cause problems. This is more so if the patient is also exposed to radiation from a CT scan and fluoroscopy. In unprotected patients undergoing CT scans, the testes could receive a dose of up to 2.21 mGy as compared to 0.39 mGy if the testes were protected.² This is true when there was no direct radiation exposure. In cases of direct radiation, this could increase to 27.7 mGy in unprotected patients.

It has been demonstrated that by using 1-mm thick lead protection devices,⁵ a reduction of up to 99.4% of the dose of radiation absorbed can be achieved in the testes as compared to unprotected patients. Romanowski and Underwood³ demonstrated a reduction of testicular dose from 0.14 mSv to 0.02 mSv by use of flat lead shields during CT scans.

Use of gonad protection shields in those patients receiving higher doses would produce a greater dose reduction than that demonstrated above. Recommendations on the use of gonad shields in UK are beyond the scope of this paper, but current legislation requires all concerned to reduce unnecessary radiation exposure to patients. The decision on whether to use a gonad protection shield for a particular patient should be made with an understanding of the expected doses to the gonads and an indication for why the X-ray is being done.

Conclusions

The guidelines should be adhered to as far as possible and effort always made to decrease radiation exposure. Clinicians, radiologists and radiographers should all take responsibility for protecting patients. Proper and regular instructions should be issued to radiographers. Regular audits are essential to ensure adherence to the guidelines.

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