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Optimum patient orientation for pelvic and hip radiography: A randomised trial

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ABSTRACT

Purpose: To investigate the effect of patient orientation on the radiation dose and image quality (IQ) for digital (DR) and computed radiography (CR) examinations of the pelvis.
Methods: A randomised study was conducted using DR and CR X-ray equipment. The standard patient orientation of head towards (HT) the two outer Automatic Exposure Device (AED) chambers was compared with a group of patients with their head away (HA) from the two outer AED chambers. Collection of mAs, source-to-skin distance and kVp data facilitated the calculation of entrance surface dose (ESD) and effective dose (ED) which were compared between groups. Each image was graded independently by three observers. IQ data were analysed for inter-observer variability and statistical differences.
Results: For DR pelvis examinations switching orientation (HT to HA) reduced the mean ESD and ED by 31% ($P < 0.001$), respectively. For CR examinations the dose reduction was greater between the two orientations (38%; $P = 0.009$). Examinations of the hips allowed dose reductions of around 50% when switching between orientations. For DR examinations minor reductions in IQ were seen and favoured the HT orientation ($P = 0.03$). For CR examinations there were no statistical differences in IQ between orientations.
Conclusion: Switching patient orientation relative to the AED chambers can help optimise radiation dose. In order to facilitate this chamber position should be clearly marked on all equipment and patient orientation should be a consideration when tailoring individual examinations. For DR minor changes in IQ are a consequence of changing orientation and should be factored into the decision making.

Introduction

In the UK, pelvis and hip radiography is one of the commonest radiographic procedures. Reports from the National Dose database estimate that the contribution of pelvic and hip radiography to the collective overall radiation dose is 1.8% and 0.28%, respectively.[1] Strategies to reduce radiation dose must be welcomed but should still allow the production of images of acceptable diagnostic quality (ALARP) principle.[2]

For radiographic examinations of the pelvis, varying the orientation of the patient relative to the automatic exposure device (AED) is one possible method of dose optimisation. Current recommendations state that the patient should have their head towards or closest to the two outer AED chambers.[3,4] Patient orientation on the imaging table can be dependent on the individual preference of the radiographer, additional examinations/projections requested and more simply original location of the pillow on the table. When using an AED it is likely that there could be differences in the radiation dose delivered as there will be different body parts overlying the chambers depending on the patient orientation. This was evident in a recent phantom study which demonstrated that when switching orientation the mean radiation dose fell by 37% ($P < 0.001$).[5] The aim of this study is to determine the optimum patient orientation for both digital radiography (DR) and computerised radiography (CR) clinical radiographic examinations of the pelvis.

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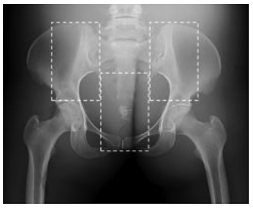
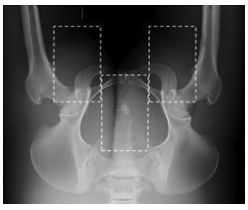
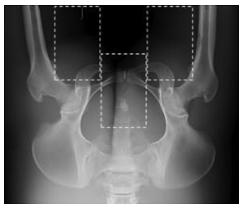
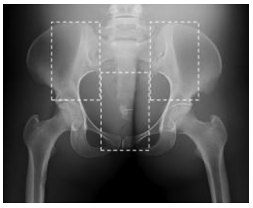
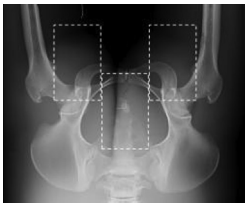
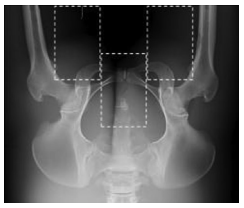
Table 1
Study group randomisation details.

Group	Room/modality	Patient orientation			
		Head towards (HT)			
		Pelvis		Hips	
1	1 – DR				
		Head away (HA)			
		Pelvis		Hips	
2	1 – DR				
		Head towards (HT)			
		Pelvis		Hips	
3	2 – CR				
		Head away (HA)			
		Pelvis		Hips	
4	2 – CR				

DR – digital radiography; CR – computed radiography. A pelvis or hip projection will be at the discretion of the individual radiographer at the time of acquisition. Approximate variations in AED chamber positions can be seen by the dotted lines.

Materials and methods

Radiography equipment

Two clinical X-ray rooms, identified as rooms 1 and 2 were used in this study. Room 1 was a Carestream Directview 7500 DR unit with dual flat panel detectors (Kodak Carestream, Rochester, NY). The DR system comprised of two cesium iodide scintillators (Trixell Pixium 4600) which were coupled to 43 cm × 43 cm amorphous non-tiled silicon photodiodes and thin film transistor (TFT) arrays (3000 × 3000 pixels with 143 μm pixel spacing) in both the wall stand and the table. The table bucky system incorporated a removable moving grid with a ratio of 12:1 (40.5 lines/cm). Room 2 was a Siemens Multix Top (Siemens Medical Solutions, Erlangen, Germany) general X-ray unit. The table bucky system incorporated a fixed antiscatter radiation grid with a ratio of 12:1 (40 lines/cm). In this room image acquisition was via a Carestream Classic CR unit (Kodak Carestream, Rochester, NY).

Equipment calibration for both rooms was performed prior to the start of the experiment. X-ray tube output and the table AED were tested for consistency at regular intervals before and during the study. All exposures were taken at 75 kVp using the two outer AED chambers. Both rooms have a total tube filtration of 3.5 mm Al and a focal spot of 1.2 mm^2 was used. The Source to Imaging Distance (SID) was maintained at 115 cm in room 1 (DR) and 100 cm in room 2 (CR) as this reflected existing local clinical practice. Imaging using both the DR and CR system also utilised standard clinical post-processing parameters for an AP pelvis examination.

Table 2
Image quality appraisal system.

Anatomical area	Classification (score)			
	Perfect (3)	Adequate (2)	Inadequate (1)	Not assessed (0)
Iliac crests				
Sacrum				
Intervertebral foramen				
Pubic and ischial rami				
Sacro-iliac joints				
Femoral necks				
Spongiosa and corticalis				
Trochanters				