Introduction:
Optimisation is imperative in radiography and is recommended by both ICRP and EMED. European figures identified pelvis and hip radiography to be third biggest contributors to dose from medical imaging in the UK, with an annual frequency of 39 per 1000 of population. Pelvic radiography is considered a high dose examination that irradiates radiosensitive organs (gonads); consequently there have been numerous attempts to reduce the amount of radiation to patients from this examination. One simple method discovered for reducing the dose for an antero-posterior (AP) pelvis is increasing source to image distance (SID). Previous studies exploring this technique have hinged mainly for film-screen based and direct digital radiography (DDR). Given the implementation of new digital imaging systems in radiography departments and the reports regarding ‘dose creep’, it is important to focus on keeping the dose as low as reasonably practicable whilst producing an image of diagnostic quality. The purpose of this study was to determine whether increasing SID for AP pelvis for a CR system, reduced dose whilst still producing an image of diagnostic quality.

Method:
Equipment: Wolverson Acroma x-ray unit (high frequency generator with VARIAN 130HS standard x-ray tube), total filtration of 3mm Al; Moving grid (ratio of 12:1, focused at 110cm ± 15cm) mounted in the Table Bucky; One image receptor (35cm x 43cm Agfa CR) with a 35-X reader. An anthropomorphic pelvis phantom was positioned on the x-ray table for an AP examination. Initial acquisition parameters used were 110cm SID, AEC using the outer chambers, 75kVp, and 0.6mm focal spot. These parameters represented standard clinical practice which permitted a reference image to be acquired. Collimation was marked in order to be kept constant at each SID. The SID was then varied (90cm to a 140cm), with two images acquired at 5cm intervals, one using the AEC and the other using a constant mAs (16mAs) derived from the AEC value of the standard acquisition parameters above.

Image quality assessment:
Perceptual:
• 2 Alternative Forced Choice (2AFC)10
• Seven experienced observers blindly graded image quality using a 5-point Likert scale and 2 Alternative Forced Choice software
• Image quality criteria for 2AFC was adapted from EGQ Criteria for Diagnostic Radiographic Images in conjunction with scales used in other literature and an unpublished psychometric image quality scale (Chronbach’s Alpha >0.8) See Fig 1.

• Experienced observer in pre operative hip templating measured femoral head diameter at each 5cm SID increment.

Objective:
• SNR using ImageJ (mean pixel value/standard deviation of the pixel value)

Radiation dose calculations:
• Entrance surface dose ESD(mGy) Unfors Calibration device (Unfors Equipments, SE)
• Effective dose (E), organ dose and effective risk with PCXMC14

Results and discussion:
Radiation dose
The results show when utilising the AEC, the ESD and E were 0.902mGy and 0.073mSv respectively at 110cm. The ESD was reduced by 17.3%, to 0.746mGy when SID was increased to 140cm. However only a 3.7% reduction to 0.071mSv was found when considering E. Without AEC, the ESD and E were 0.917mGy and 0.074mSv respectively at 110cm but were greatly reduced by 50.13% and 41.79% at 140cm (Table 1a and 1b).

The risk of exposure-induced death from cancer for a 15 and 60 year old when utilising the AEC for both 110cm and 140cm is five per million and three per million, respectively. The risk reduces when the AEC is not used and the SID is at 140cm to three per million and two per million respectively.

Image quality
The results demonstrated that when SID was increased (with and without AEC), improvement in image quality was not significantly different (p = 0.967). Intra Class Correlation value for the seven observers was 0.77 (95% confidence interval) proposing a high level of consensus suggesting that the scale was appropriate and the results credible.

The SNR results did however reveal a slight decrease in image quality at increased SID (see table 1a and 1b).

| Table 1a | The relationship between the mean SNR, perceptual image quality scores, ESD and E when AEC is utilised at varying SID |
| --- | --- | --- | --- |
| SID (cm) | SNR | Image 1 | Image 2 | Image 3 |
| 110 | 0.902 | 0.917 | 0.917 | 0.917 |
| 120 | 0.436 | 0.436 | 0.436 | 0.436 |
| 130 | 0.236 | 0.236 | 0.236 | 0.236 |
| 140 | 0.140 | 0.140 | 0.140 | 0.140 |

When SID was increased from 110cm to 140cm femoral head diameter reduced by 5.4mm. Radiographers should be cautious when introducing an increased SID into clinical practice as it may lead to issues with interpretation if images are acquired at different SID for the same patient. Nevertheless, SID could be annotated onto an image alternatively a ruler or other measuring device could be acquired at the same time so that magnification can be taken into account.

Our data demonstrates that dose reduction can be identified with as little as 5cm SID increments, which is of interest because earlier studies suggest that increments of 10cm are needed to see a dose reduction effect. In addition, a majority of studies have utilised the AEC or increased mAs at each SID increment to keep the dose constant at the detector. Our study, however, used a constant mAs (derived from the standard acquisition parameters used for the reference image) for all SID increments and found that image quality could still be maintained without the need for a consequent increase in dose.

Conclusion:
Within the parameters of this study it was demonstrated that increasing SID for AP pelvis imaging using CR reduces both ESD and E with no significant impact on image quality. The reduction in radiation dose at increasing SID is greater when exposures are manually set. Increasing SID is a simple and cost-effective means of reducing dose to patients and should be considered and explored further in clinical practice.