Using Exposure Index to Develop Thickness Based Technique Chart for Cross-Table Lateral Hip Radiography

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INTRODUCTION

Cross-table lateral hip radiography is commonly performed to assess hip fracture or dislocation in trauma or surgery patients. Technique optimization for this exam is complex due to the absence of automated exposure control (AEC), atypical patient positioning, ineffective scatter reduction, and the possible use of additional beam filtration.

AIM

To establish a thickness-based technique chart by using the exposure index (EI) as a surrogate for AEC to achieve consistent image receptor air kerma across patient sizes.

METHOD

- Cross-table lateral hip thickness and the corresponding image field-of-view size were measured from 68 clinical patient exams to establish a mathematical relationship between the two (Figure 1.A).
- This relationship was used to guide the development of a thickness-based technique chart for a clinical digital radiography system (Discovery XR656 HD, GE Healthcare).
- Lucite blocks were used to simulate patient attenuation. They were arranged on the tabletop to mimic the typical exam set-up with a source-to-image distance of 50 inches and a clip-on grid (Figure 1.B).
- Exposures were made at 85 kV, the current clinical setting, for five lucite thicknesses, representing 10th, 25th, 50th, 75th and 90th percentile cross-table lateral hip thicknesses. Field-of-view size appropriate for each hip thickness was used (Table 1).
- For each exposure, mAs, incident air kerma, and the IEC EI (central 10% region of the image) were recorded. The measurements were then repeated with an additional 0.2-mm copper filtration.
- From this data, the mAs needed to achieve a constant EI of 350 was derived for each hip thickness. The corresponding incident air kerma was also calculated.

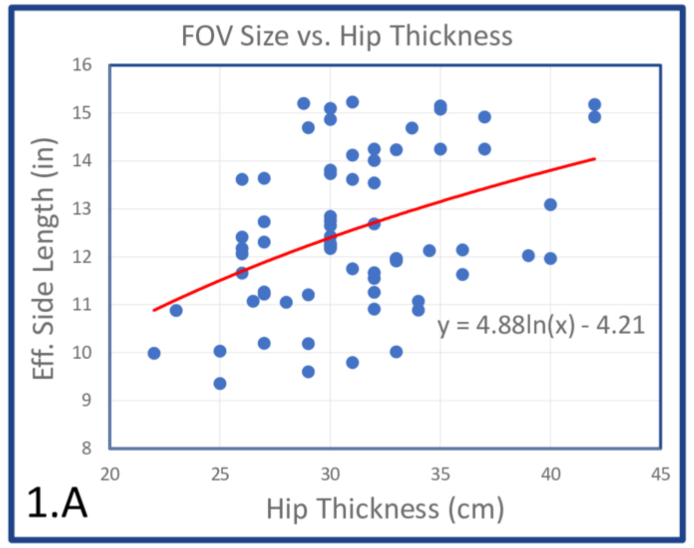

***Figure 1**: **A.** Measurements from 68 clinical exams were used to establish a mathematical relationship between image field-of-view size (effective side length) and cross-table lateral hip thickness. **B.** The logarithmic relationship in Figure 1.A was used to determine the appropriate field-of-view sizes for five lucite thicknesses, representing 10th, 25th, 50th, 75th and 90th percentile cross-table lateral hip thicknesses (Table 1). The experimental setup mimicked a clinical exam.*

Percentile	Cross-Table Lat. Hip Thickness (cm)	Effective FOV Size (in)
10th	26.0	11.7
25th	28.2	12.1
50th	30.5	12.5
75th	33.0	12.9
90th	37.0	13.4

***Table 1**. The 10th, 25th, 50th, 75th and 90th percentile cross-table lateral hip thicknesses and the corresponding effective field-of-view (FOV) sizes.*

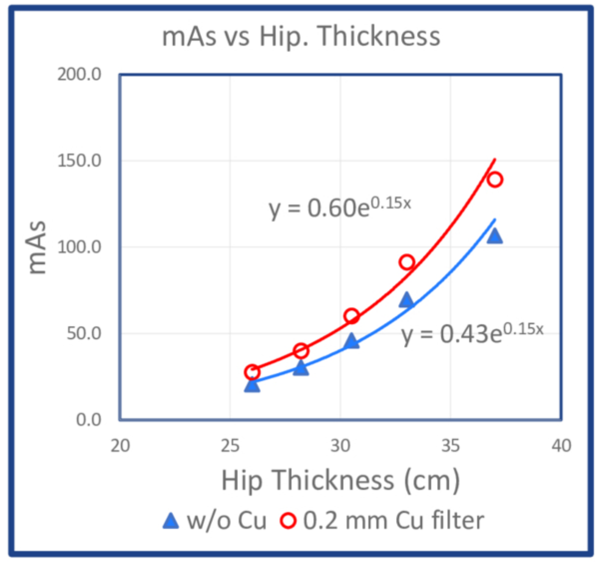

***Figure 2.** To achieve a constant EI of 350, the required mAs increased exponentially with hip thickness (r^2=0.99). As expected, the required mAs values were higher when an additional 0.2-mm copper filtration was used.*

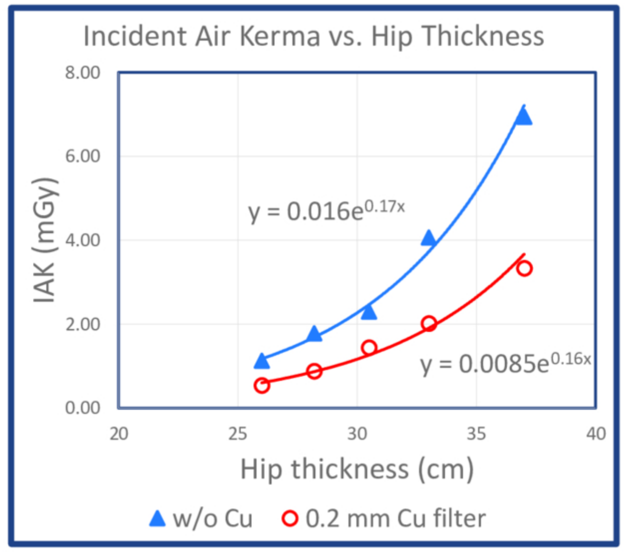

***Figure 3.** Measured incident air kerma increased exponentially with increasing hip thickness. The use of an additional 0.2-mm copper filtration reduced incident air kerma by about 50%.*

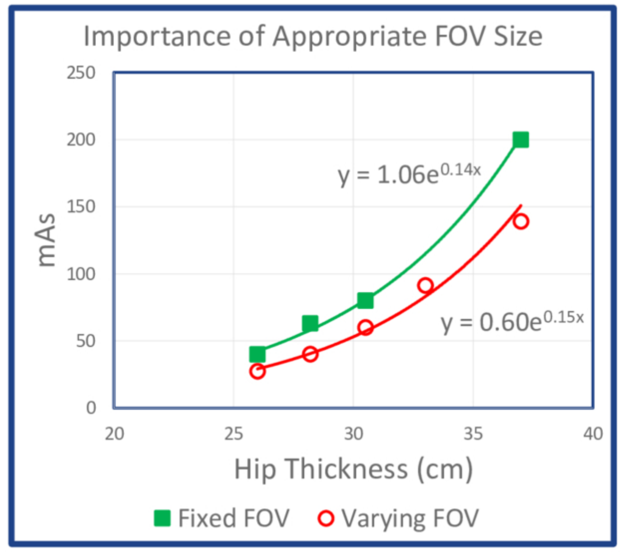

***Figure 4.** The importance of adjusting field-of-view (FOV) size based on patient thickness. A pilot experiment was performed using a fixed FOV size for all hip thicknesses (approximately 10 × 10 inches, limited to the area of a single lucite block). The resulting mAs values were appreciably higher compared to the final experiment in which FOV size was varied based on hip thickness to match the trend observed in clinical patient exams (Figure 1).*

RESULTS

- To achieve a constant EI of 350, the required mAs increased exponentially with the cross-table lateral hip thicknesses (r^2=0.99) (Figure 2).
- For 10th, 25th, 50th, 75th and 90th percentile hip thicknesses, the required mAs values were 21, 30, 46, 70, and 107, respectively without copper filtration and 28, 40, 60, 91 and 140, respectively, with copper filtration (Figure 2).
- For the five patient thicknesses, incident air kerma was approximately 50% lower when copper filtration was used (Figure 3).
- It is important to adjust field-of-view (FOV) size based on patient thickness (Figure 4) Because a clip-on grid in a table top exam does not reduce scatter as effectively as bucky grids, using clinically realistic field size is important as it more accurately accounts for the scatter conditions in patient exams.

INNOVATION / IMPACT

- The most interesting finding of our study was that for a given clinical system (e.g., Discovery XR656 HD, GE Healthcare) and beam quality (e.g., 85 kV and 0.2-mm additional copper filtration), to achieve the same EI across patient sizes, the required mAs was an exponential function of anatomical thickness (Figure 2).
- Our results suggest that such a relationship can be established experimentally using a small set of representative thicknesses, but can then be applied to any thickness in between.
- This relationship allows the creation of a thickness-based technique chart with any desired gradation.
- Because EI scales linearly with mAs, one can also adjust the EI target (e.g., 350) retrospectively to increase or decrease the required mAs based on the perceptual feedback provided by the radiologists.

CONCLUSION

By creating a realistic clinical setup and adjusting manual technique to achieve a constant EI across patient sizes, we successfully developed a thickness-based technique chart for cross-table lateral hip radiography.

CONTACT INFORMATION

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