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Low Radiation from Lumbar Spine QF

Quantitative fluoroscopy (QF) is an emerging technology for assessing continuous inter-vertebral motion in the lumbar spine. Automated frame-to-frame image registration provides continuous inter-vertebral rotational and translational data, giving more information about the function of the spine than AP, lateral, or flexion-extension (functional) radiographs.

Functional radiographs have long been used for measuring spinal movement and for diagnosing instability. However, such measurements are unreliable due to errors from positioning, distortion and magnification. QF technology is mainly limited to research, although a new system for clinical use has recently gained 510(K) clearance from the United States Food and Drug Administration (KineGraph VMA, Ortho Kinematics, Austin, Texas, USA). However, few authors have published radiation dose data and none have compared these to published data from radiographic images. The present study sought to provide this, with suggestions for further optimising radiation doses by analysis of the characteristics which contribute to dose.

The aim was to determine if QF investigation of the lumbar spine imparts a similar dose-area product (DAP) and effective dose (ED) to lumbar spine radiographs. To determine this, published data for AP and lateral radiographs were interrogated. Because no published data exist for functional radiographs, local hospital data were used to represent this dose for comparison. A secondary aim was to determine which factors may contribute to a reduction of the dose from QF.

Method

Internationally reported DAP and ED data for lumbar spine radiographs were compared with the same for QF and with data from a local hospital for functional radiographs (weight bearing AP, lateral, and/or flexion and extension) (n = 27). DAP is measured in Gray multiplied by area (Gy cm2) and ED in miliSievert (mSv).

Recruitment of all participants and their written informed consent were carried out by the principal researcher prior to screening. QF was undertaken in the recumbent coronal and sagittal planes, in a cross-sectional mixed gender study (n = 74) of in vivo lumbar spine biomechanics, and movement was controlled by a specially designed motorised motion table. Data collection was undertaken by the principal researcher using a portable digital C-arm fluoroscope with a 30 cm Image Intensifier (Siemens Avantic, Germany), and a pulse rate of fifteen frames per second was selected to minimise movement blurring.

DAP was then converted to ED using PCXMC v2 software (stuk.fi) and 2007 ICRP 103 tissue weighting factors. For QF, the mean kVp was 67 for coronal and 79 for sagittal plane, and the mean focus skin distances (FSD) were 75 cm and 60 cm respectively. The effects of procedure time, age, weight, height and body mass index on the fluoroscopy dose were determined by multiple linear regression using SPSS v19 software (IBM Corp., Armonk, NY, USA).

Results and Conclusion

The effective dose (and therefore the estimated risk) for QF is 0.561 mSv which is lower than in most published data for lumbar spine radiography.

The DAP for sagittal (flexion + extension) QF is 3.94 Gy cm2 which is lower than local data for two view (flexion and extension) functional radiographs (4.25 Gy cm2), and combined coronal and sagittal dose from QF (6.13 Gy cm2) is lower than for four view functional radiography (7.34 Gy cm2).

Conversely, DAP for coronal and sagittal QF combined (6.13 Gy cm2) is higher than that published for both lumbar AP or lateral radiographs, with the exception of Nordic countries' combined data.

Weight, procedure time and age were independently positively associated with total dose, and height (after adjusting for weight) was negatively associated. Thus, as height increased, the DAP decreased.

While QF could be used as a replacement for functional radiographs without an increase in radiation dose, this technique requires careful standardisation of patient movement and bespoke tracking algorithms which are essential for accuracy and reliability. Hence its wider adoption within clinical departments will require careful management. However, this technique has already been adopted in the USA and work is underway to improve its accessibility in the UK.

Reference:

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