Purpose: To study the depth-dose delivery of a novel kilovoltage source using Monte Carlo (MC) simulations.

Methods: The large area scanning beam x-ray source (SBDX) designed for fluoroscopic imaging was modeled for diverging and converging beamlets. The MC model of SBDX was built in the EGSnrc/BEAMnrc code and validated against EBT Gafchromic film measurements in the DOSXYZnrc code. The SBDX was modeled as a number of highly collimated 120 kV x-ray sources distributed along a line. Simulations were performed of the source arcing around a target beneath the surface in a soft tissue human-sized phantom. The design of the source was optimized to minimize skin dose with a high beam output. A comprehensive study of the source design included the investigation of incident electron beam arrangement, and collimator design, as well as x-ray delivery setup, such as the source-to-surface distance and beam angles.

Results: SBDX depth dose curves for three energies simulated by MC agreed with the measured ones to within 5%. The comprehensive study of the source's design parameters and x-ray delivery setup determined optimum parameters for high depth-to-skin ratios and beam output of the novel 120 kV source. With these parameters, a 4-cm diameter, subsurface target was covered with a 75% isodose line, and the corresponding target-to-skin ratio was 2.74. Another set of source parameters resulted in a target-to-skin ratio of 3.03, however, the beam output was by 80% lower.

Conclusions: The dose distributions created with a novel kilovoltage source have been studied using MC simulations, and a possible design for clinical use has been determined.

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