Purpose: To evaluate the dependence of central axis doses and output factors of square fields formed by scanning proton beamlets on the lateral profiles of the beamlets.
Method and Materials: Square field dose distributions in a water phantom, delivered by proton beamlets used for scanned beam proton therapy, were simulated with MCNPX. Normalized central axis doses as a function of field size and depths in the phantom, the output factors, were analyzed and compared to measured values. Lateral profiles of the simulated beamlets were adjusted to closer fit characteristics of measured beamlet profiles, and to improve the agreement of output factors for measured and simulated doses and output factors.
Results: Our results revealed that small changes in the low dose parts of lateral profiles far from the central axis (i.e., the "halo") of proton beamlets produced significant changes in the central axis doses of square fields. This indicates the importance of low-dose halo around individual beamlets in the context of modeling beams for dose prediction purposes.
Conclusion: Our findings suggest that the accuracy of dose prediction algorithms for scanned beam proton therapy is highly dependent on correct modeling of the halo doses far from the beam axis. Because contemporary dose prediction algorithms do not calculate doses with a large enough lateral extent for reasons of maintaining acceptable calculation times, results of this research may help develop novel and more accurate algorithms for dose computations for scanned charged particle beams.

Funding Support, Disclosures, and Conflict of Interest:

This project was supported in part by P01CA021239 from the National Cancer Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health.