Improving cervical volumetric dosimetry with combined intracavitary/interstitial brachytherapy

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Abstract

Purpose. Standard curative treatment of locally advanced cervical cancer involves external beam radiotherapy (EBRT) +/-chemotherapy followed by intracavitary brachytherapy (ICB). Interstitial brachytherapy (ISB) techniques may be a consideration for large tumors, extensive parametrial residuum, or unfavorable topography. With volumetric planning, GEC-ESTRO planning aims for tumor target and organs-at-risk (OAR) are the norm. Further dosimetric optimization could be important for improved local control and decreased toxicity. A broader application of combined ICB+ISB for cervical cancer, regardless of clinico-anatomical factors, may facilitate such dosimetric optimization.

Methods. We reviewed the EBRT+ICB plans generated at our institution from 2012-2015, including for 28 women treated on a study of MRI-guided brachytherapy. We identified cases where GEC-ESTRO recommendations were met, but total D90 HR-CTV <90Gy10. HR-CTV volume and dose data were collected for D 90 HR-CTV, rectum, bladder, and sigmoid (expressed as total dose for EBRT+brachytherapy, in EQD2). Cases were categorized by volume. Using Oncentra 4.3 (Elekta, Sweden) planning software, virtual ISB needles were retrospectively added to these plans and further optimization undertaken. Needle (n=2–5) positions and depths were tailored to anatomy, with fixed conformation modelled on our tandem+ring+needle system. Dosimetry for ICB and ICB+ISB was compared.

Results. Eleven cases were identified (46% FIGO stage IB, 18% IIA, 36% IIB) (median 29.5cc [18.1 - 78.2cc]). For ICB, median D90 HR-CTV was 86.9Gy10 [81.0 - 89.9Gy10], and D2cc for rectum 58.3Gy3 [49.2 - 66.8Gy3], bladder 64.3Gy3 [57.9 - 90.3Gy3], and sigmoid 64.3Gy3 [52.6 - 74.9Gy3]. For ICB+ISB, median D90 HR-CTV was 90.8Gy10 [88.4 - 94.9Gy10], with D2cc rectum, bladder, and sigmoid of 58.5Gy3 [49.8 - 71.6Gy3], 64.8Gy5 [58.5 - 85.0Gy3], and 67.5Gy3 [52.6 - 73.8Gy3], respectively. D90 HR-CTV was increased by 0.7 - 10.0Gy10, slightly higher for larger (≥30cc) volumes (median 7.2, vs. 3.9Gy10). Minimal changes in median D2cc were seen for rectum (0.1Gy3 [-1.9 - 4.8Gy3]), bladder (0Gy3 [-9.6 - 3.7Gy3]), and sigmoid (0.9Gy3 [-2.2 - 4.2Gy3]) overall. Our institutional planning aims were met in all but one ICB+ISB cases. Needle positions were observed to be a factor: those placed on the opposite side to the dose-limiting OAR helped mitigate OAR doses. Conclusion. In this planning exercise, combined ISB+ICB can increase D90 HR-CTV while simultaneously improving the ability to minimize OAR doses. Knowledge gained
of the relationship between needle positions, anatomy, and relative weighting can assist in making an informed decision prior to an ICB+ISB implant. Clinical feasibility for individual patients requires further investigation.