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abstract

Optimizing Quality of Life in Cervical Cancer Survivors: A Comparative Study of Vaginal Doses Delivered Using Three HDR Brachytherapy Applicators

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Optimizing Quality of Life in Cervical Cancer Survivors: A Comparative Study of Vaginal Doses Delivered Using Three HDR Brachytherapy Applicators

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Introduction: With continuous improvements in cancer therapy, long-term survival in cervical cancer patients has significantly increased. As a result, quality of life (QoL) has become a key clinical endpoint alongside tumor control. At the same time, increasing patient volume puts pressure on radiotherapy services, underscoring the need for efficient, reproducible treatment workflows. This study compares three intracavitary HDR brachytherapy applicators to evaluate their impact on vaginal and recto-vaginal dose distribution, as well as planning and optimization efficiency.

Methodology: A retrospective study was conducted on 45 patients with locally advanced cervical cancer treated with concurrent chemoradiation followed by CT-based image-guided adaptive brachytherapy (IGABT). All patients received external beam radiotherapy of 45 Gy in 25 fractions with concurrent chemotherapy, followed by HDR brachytherapy delivering 8 Gy per fraction for three fractions to the high-risk clinical target volume (HR-CTV). Vaginal dose was assessed using GEC-ESTRO reference points, including PIBS, PIBS+2 cm, PIBS−2 cm, and recto-vaginal reference point (RV-RP). Doses were converted to EQD2 using an α/β ratio of 3 Gy, treating the vagina as an organ at risk. Dosimetric comparison was combined with analysis of the planning and optimization workflow for each applicator.

Results: All applicators achieved comparable HR-CTV coverage, with similar HR-CTV D90 values. However, vaginal and recto-vaginal doses were strongly geometry-dependent. The Fletcher Suit Delclos (FSD) applicator delivered significantly higher vaginal doses at PIBS reference points, while the Ring applicator demonstrated significantly lower doses at the recto-vaginal interface. Miami showed intermediate normal tissue dose values. Bladder and sigmoid doses were comparable across applicators, while the rectal dose was lowest with the Miami applicator. In terms of workflow, the Miami applicator demonstrated shorter planning and optimization time, with improved control of dose gradients due to its multi-channel design, providing greater flexibility in shaping dose distribution.

Conclusion: This was a retrospective single-center

study. Workflow metrics were based on clinical practice and manual observation rather than automated timing tools. Applicator geometry is not merely a technical parameter, but a key determinant of vaginal and recto-vaginal dose, planning efficiency, and patient quality of life in modern cervical cancer IGABT. While all applicators provided comparable tumor coverage, significant differences in normal tissue dose and workflow were observed. The Miami applicator demonstrated faster planning with enhanced dose shaping capability, supporting the importance of personalized applicator selection to optimize toxicity, efficiency, and survivorship outcomes.

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