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Comparative analysis of rectal dose parameters in image-guided high-dose-rate brachytherapy for cervical cancer with and without a rectal retractor

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ABSTRACT

PURPOSE: The objective of this study was to determine if use of a rectal retractor (RR) in high-dose-rate intracavitary brachytherapy for cervical cancer reduces rectal dose parameters.

METHODS AND MATERIALS: We reviewed data obtained from patients treated with intracavitary brachytherapy for cervical cancer with and without an RR. Treatment plans for each brachytherapy fraction were separated into two groups; R group with use of an RR and P group with use of vaginal packing. Dose–volume parameters for high-risk clinical target volume (HR-CTV), rectum, sigmoid, small bowel, and vaginal surface were collected for each fraction. Rectal D_{2cc} and International Commission on Radiation Units & Measurements (ICRU) rectal point doses were compared between groups using Student's *t* tests. Predictors of higher rectal D_{2cc} were determined by univariate and multivariate regression analyses.

RESULTS: Four hundred sixty-three brachytherapy fractions from 114 patients were used for analysis, 377 fractions with a RR (R group) and 86 with vaginal packing only (P group). Both groups were similar except for slightly higher mean HR-CTV and mean bladder volume in P group. Both mean ICRU rectal point dose (241.1 vs. 269.9 cGy, $p = 0.006$) and rectal D_{2cc} (240.6 vs. 283.6 cGy, $p < 0.001$) were significantly higher in P group. Point A dose, HR-CTV, stage, and use of an RR were significant predictors of rectal D_{2cc} on multivariate analysis.

CONCLUSIONS: Our data show that use of an RR leads to lower rectal dose parameters compared with vaginal packing. Further study is needed to determine if this will lead to less long-term toxicity.

Keywords: Cervix; HDR; Brachytherapy; Rectal; Retractor

Introduction

High-dose-rate (HDR) intracavitary brachytherapy (ICB) for cervical cancer has become a mainstay of treatment of cervical cancer and has replaced low-dose-rate brachytherapy in many institutions. Use of HDR brachytherapy has risen steadily and now represents approximately two-thirds of cases of cervical cancer treated with ICB in Canada and up to 85% of cases worldwide (1–3). With the increase in use of HDR brachytherapy, there has also been an increase in the use of ring and tandem applicators, which can increase the reproducibility of intracavitary insertions and reduce their complexity (1–4). With the introduction of CT image guidance, and, more recently, MRI guidance, to brachytherapy planning protocols, clinicians are much more aware of the utility of dose–volume parameters in characterizing dose to target volumes and organs at risk (OAR). Many guidelines have now been published on the basis of these parameters (5–10), and current practice relies

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on quantities such as $D_{0.1cc}$, D_{1cc}, and D_{2cc} for bladder and rectum, OAR in cervical cancer HDR ICB (8, 11).

With the transition to HDR brachytherapy, many have expressed concern about long-term toxicity because of the large doses per fraction at high dose rates (12). Multiple studies have shown an overall risk of late rectal toxicity ranging from 37% to 55% and risk of severe late toxicity ranging from 1% to 10% (11, 13–17). A clear correlation between ICRU rectal point dose, rectal $D_{0.1cc}$, D_{1cc}, as well as D_{2cc}, and late rectal toxicity has also been established (11, 13–15). To counter these effects, one of the underlying principles of gynecologic ICB is to attempt to increase the distance to the OARs from the applicators, thereby reducing the dose received by the OAR. For the rectum, this was traditionally done by means of vaginal packing, which has been reported to reduce rectal dose by as much as 12% (18). Others have attempted to use intravaginal Foley catheter balloons or variable geometry inflatable balloons, practices that have not been widely adopted (19–22). However, more recent commercially available ring and tandem applicator sets use rectal retractors (RRs) incorporated into the applicator set to reduce dose received by the rectum. These systems would intuitively be effective in distancing the rectal mucosa from the applicator, but very little data to this effect are available. A relatively small Korean study with two-dimensional planning showed a reduction in rectal point doses when RRs were used with tandem and ovoid applicators but did not evaluate volumetric dose parameters because they did not use three-dimensional (3D) imaging (23). We know of no such data published solely regarding tandem and ring applicators. A true randomized comparison of dose parameters with and without an RR would be logistically challenging as it would require imaging with and without the retractor and vaginal packing in place.

Recently, one commercially available RR has been globally recalled because of a possible risk of fluid cross-contamination (24). At our center, this meant that use of this retractor in ring and tandem applications had to be discontinued, and vaginal packing was used in lieu of the retractor. From clinical experience thereafter, this prompted us to hypothesize that ICB insertions done with a ring and tandem applicator with vaginal packing only would have less favorable rectal volumetric dose parameters as compared with ICB insertions done with an RR. We therefore set out to compare rectal dose parameters obtained with and without the use of an RR. Secondary objectives were to determine if use of an RR resulted in changes in dose–volume parameters for the bladder, sigmoid colon, and small bowel. To achieve these objectives, we undertook a retrospective comparative analysis of women treated

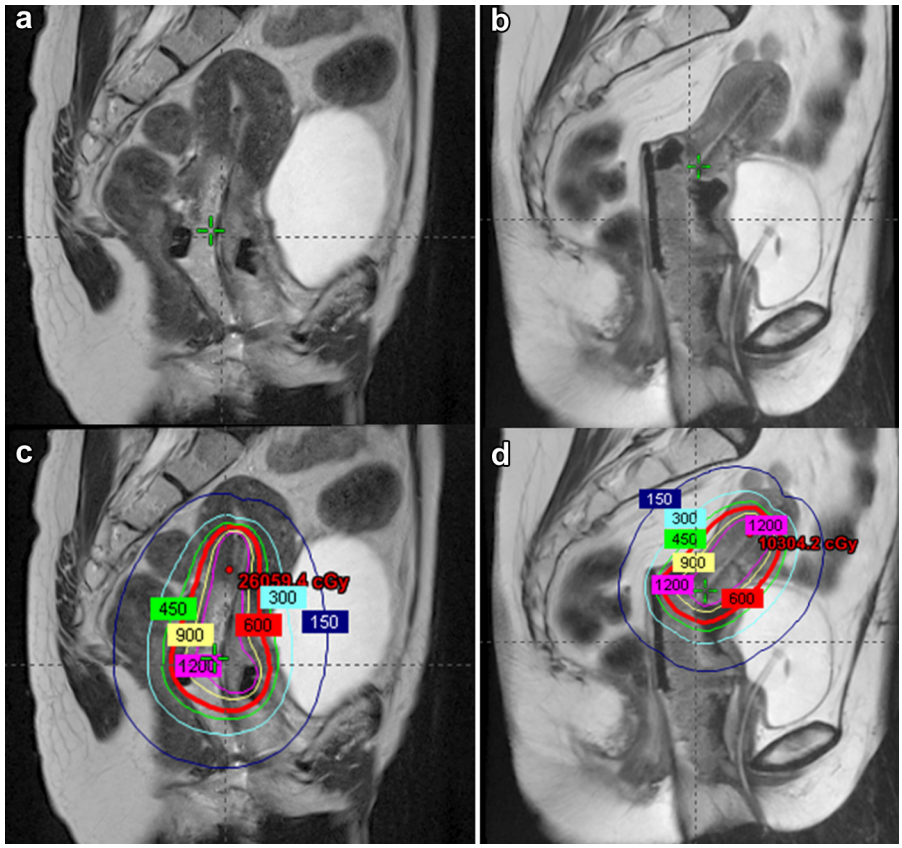

Fig. 1. Images taken from two different brachytherapy treatments with and without rectal retractor showing rectal displacement effects for each technique. Image (a) shows applicator placement without a rectal retractor. Image (c) shows this same application with dosimetry overlaid on MRI image. Image (b) shows applicator placement with a rectal retractor. Image (d) shows this same application with dosimetry overlaid on MRI image.