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Prospective comparison of rectal dose reduction during intracavitary brachytherapy for cervical cancer using three rectal retraction techniques

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ABSTRACT

PURPOSE: To compare three rectal retraction methods on dose to organs at risk, focusing on rectal dose, in cervix cancer patients treated with high-dose-rate intracavitary brachytherapy.

METHODS AND MATERIALS: A prospective study was conducted on patients with cervical carcinoma treated with chemoradiotherapy, including external beam radiation and four fractions of high-dose-rate intracavitary brachytherapy prescribed to Point A using a ring and tandem applicator under conscious sedation. Rectal retraction methods included: a rectal retractor blade (RR), vaginal gauze packing (VP), and a tandem Foley balloon (FB). All three methods were used in all patients. The RR was used first, and the following applications were randomly assigned to VP or FB. CT planning was used to calculate D_{2cc} for rectum, sigmoid, small bowel, and bladder. The Wilcoxon signed rank test was used to determine if the median dose differences between methods were statistically significant.

RESULTS: In these 11 patients, median dose (min, max) in cGy to the rectum using RR, FB, and VP was 131 (102, 165), 199 (124, 243), and 218 (149, 299), respectively. The RR demonstrated lower median intrapatient doses to rectum compared with FB and VP (−55 cGy; $p = 0.014$ and −76 cGy; $p = 0.004$, respectively). The RR also resulted in lower sigmoid doses. No differences in dose were observed between the VP and FB methods.

CONCLUSION: The rectal retractor significantly reduced the dose to rectum and sigmoid compared with FP and VP. In patients treated under conscious sedation, the RR method provides the best rectal sparing. There were no significant differences in dose observed between the FB and VP techniques.

Keywords: Cervical cancer; Brachytherapy; Rectal dose; Retractor

Introduction

The standard treatment for women with FIGO stage IB-IVA cervical cancer is chemoradiotherapy. Radiation is delivered by two techniques: (*1*) external beam radiation (EBRT) and (*2*) intracavitary brachytherapy, typically using a high-dose-rate (HDR) technique, which delivers large radiation doses to the tumor, however, risks late toxicities due to potential dose to organs at risk (OARs). Moderate-to-severe late complications from HDR brachytherapy have been reported to range from 5% to 30% (1−8). A common site for radiation side effects after HDR brachytherapy for cervix cancer is the anterior rectal wall, which may cause rectal bleeding, fibrosis, chronic rectal ulcers, and fistula formation (4, 6). There exists a strong correlation between rectal dose and rectal toxicity (4−6). It is thus essential to keep the radiation dose to the rectum as low as possible to minimize the incidence and severity of these complications. This is conventionally done by moving the rectum away from the brachytherapy sources.

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There are three standard methods to displace the rectum posterior from the vagina and the cervical canal during brachytherapy: (*1*) vaginal gauze packing (VP), (*2*) a commercially available rectal retractor blade (RR) composed of plastic that is hinged behind the applicators, and (*3*) vaginal balloon(s) placed on the uterine tandem which are inflated to displace nearby normal tissues. At our center, the rectal retractor is used if there is sufficient space in the vaginal cavity to accommodate its placement. If patient anatomy does not allow for the use of the rectal RR, either VP or a vaginal balloon is used for rectal retraction. We developed a local method of vaginal balloon retraction using a Foley catheter balloon threaded onto the tandem and inflated with fluid (referred to from here on as ''tandem Foley'' Fig. 1).

At present, we are aware of no prospective studies that have compared the three methods of rectal retraction with regard to the dose delivered to the rectum and other OARs, as determined by three-dimensional volumetric imaging. This study was therefore undertaken to compare dose delivered to the rectum using three methods of rectal retraction. Secondary objectives were to compare doses delivered to bladder, sigmoid, and small bowel. To achieve these objectives, we conducted a prospective cohort study of consecutive patients treated with HDR brachytherapy for cervix cancer.

Method and materials

All patients with FIGO stage IB2 and IIB cervical cancer with no history of prior pelvic radiation treated with HDR brachytherapy and able to tolerate the rectal RR were eligible for this study. The study was approved by the local Research Ethics Board before initiation. Patients received EBRT with concurrent cisplatinum chemotherapy and HDR intracavitary brachytherapy. A dose of 45 Gy in 25 fractions was delivered by EBRT, whereas a dose of 26 Gy to Point A was given by HDR brachytherapy in 4 weekly fractions (6.5 Gy per fraction) beginning after at least 3 weeks of EBRT.

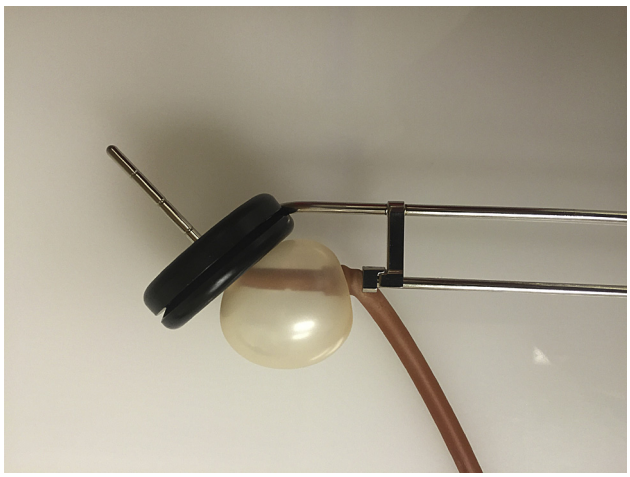

Fig. 1. A photograph of the tandem Foley on a ring and tandem applicator.

The brachytherapy procedures occurred within the HDR brachytherapy suite under conscious sedation with intravenous Fentanyl and Midazolam. Insertion of the intrauterine tandem was aided by the use of transabdominal ultrasound. In all cases, a ring and tandem applicator was used and radiation was delivered using an ^{192}Ir source from a VariSource iX afterloader (Varian Medical System, Palo Alto, CA). Patients were eligible for the study if, at the time of the first insertion, the radiation oncologist was able to successfully insert the rectal retractor into the vagina. Prior to the second fraction patients were consented to participate in the study. The rectal retraction technique for the subsequent two insertions was chosen randomly between the tandem Foley and VP to decrease the chance for bias. The tandem Foley was a Foley catheter threaded onto the uterine tandem with the Foley balloon (FB) inflated with 30 mL of saline and contrast (5 mL of contrast, 25 mL of saline, Fig. 1). For the final fraction, the retraction method was chosen by the physician. Therefore, each patient had all three techniques used at least once.

CT scans were obtained after each insertion with bladder and rectal contrast to aid in organ delineation. To verify that the tandem Foley was effective in decreasing dose to rectum, when the Foley tandem was used as the retraction method, two CT scans were obtained: one with the catheter completely deflated (to serve as a baseline, as if no retractor method was used) and one with the catheter inflated. Patients were treated with the Foley tandem inflated on these insertions. Posttreatment plans were generated using the CT scan in the BrachyVision planning system (Varian Medical Systems) to calculate dose to OARs. The bladder, rectum, sigmoid, and small bowels were contoured by a single experienced dosimetrist, and all contours were reviewed by a radiation oncologist to ensure accuracy and consistency in contouring. From the resulting dose-volume histogram, the minimum dose to the most irradiated volume (D_{2cc}) was determined for each OAR for each insertion using each retraction technique. Henceforth, the D_{2cc} will be referred to as dose in this article. A typical CT image of each retraction method is shown in Fig. 2(a−c) for the same patient. Rectal and bladder dose points, as described by the ICRU report 38, were also collected for each retraction method and analyzed (9). Because the results were very similar to those seen using the volumetric dose parameters, these results are not presented in this manuscript.

The primary metric of interest was the dose to the rectum, although dose to all the relevant OARs was collected. Because all patients received treatment using all three methods, patients acted as their own internal control, eliminating the variations caused by anatomical differences between patients. Doses (D_{2cc}) were calculated for all OARs.