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Novel use of a vaginal cylinder purposed dually as obturator and localiser for stereotactic ablative radiotherapy delivery

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Case Study

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Abstract

Background: Vaginal cancer is a rare malignancy that poses a challenge to treat and cure, as surgical excision requires life-changing procedures because of the proximity and involvement of rectum, bladder and anus. We report in this case study the successful delivery of stereotactic ablative radiotherapy (SABR) for a patient with vaginal cancer after previous radiotherapy.
Methods: A 71-year-old white female who presented with dyspareunia and irritative urinary symptoms proven by biopsy was our candidate patient. Subsequent PET/CT revealed a hypermetabolic 3 cm lesion at the 12–1 o'clock position in the distal vagina involving the clitoris. The patient was initially treated with volumetric-modulated arc therapy (VMAT) with simultaneous integrated boost technique to the involved nodes, and later upon recurrence treated with SABR using 30 Gy in six fractions.
Findings: To our knowledge, this is the first report of a vaginal cylinder used to physically distance organs at risk from the treatment target and also as a localising device with image guidance for the delivery of SABR using an external beam.

Introduction

Vaginal cancer is a rare malignancy affecting 6,230 patients per year and resulting in 1,450 annual deaths.[1] Vaginal cancer is a challenge to treat and cure as surgical excision frequently requires life-changing exenterative procedures due to the proximity and frequent involvement of the rectum, anus and bladder.[2–6] Radiation, and more recently, chemoradiotherapy have become the mainstays of treatment with pelvic control rates of 75–85% for stage II lesions and 25–70% for stage III lesions.[4,7–10] We report the successful delivery of salvage stereotactic ablative radiotherapy for a patient with persistent vaginal cancer at the introitus involving the urethra and clitoris after previous radiotherapy.

Clinical history

Our patient was a 71-year-old white female at diagnosis, presenting with dyspareunia and irritative urinary symptoms. A vaginal biopsy at an outside facility confirmed the presence of well-differentiated squamous cell carcinoma (large cell keratinising) in a 2 cm lesion in the distal vagina near the urethral orifice. PET/CT performed for staging showed a hypermetabolic vaginal mass with a standard uptake value (SUV) of 29·7 as well as obturator and inguinal nodal metastases. An examination under anaesthesia (EUA) and fiducial marker placement with cystoscopy was performed at our facility in preparation for definitive chemoradiotherapy. The examination at that time showed a 3 cm lesion at the 12–1 o'clock position in the distal vagina and extending into paravaginal tissue, slightly to the left side of the urethral orifice and involving the clitoris. Cystoscopy showed extrinsic urethral compression, but no direct intraluminal invasion. According to the American Joint Committee on Cancer (AJCC),[11] her final AJCC stage pretreatment was T2b N1 M0 (Stage III). She signed informed consent to participate in the NRG Oncology GY 006 trial,[12] which randomises patients with the primary pelvis-contained cervix or vaginal cancer to pelvic radiotherapy with radio-sensitising cisplatinum at 40 mg/m^2 +/− triapine, a radiosensitizer, randomising to the arm with added triapine.

According to the protocol, her radiation was delivered using volumetric-modulated arc therapy (Rapid Arc, Varian Medical Systems, Palo Alto, CA, USA) and a simultaneous integrated boost technique with external beam to the involved nodes, delivering 47·6 Gy to the primary and uninvolved nodes and 59·36 Gy to the hypermetabolic nodal tissue in 28 fractions. Initially compliant with treatment, the first 25 fractions were delivered over 40 elapsed days with

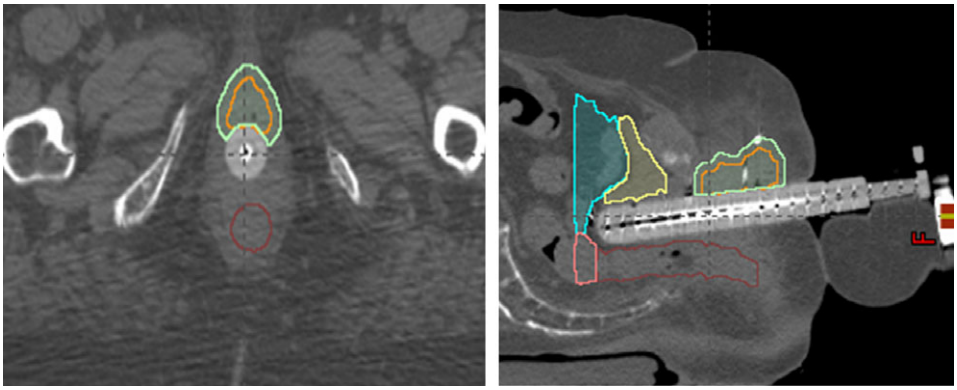

Figure 1. Separation of organs at risk such as rectum from the gross tumour volume (orange) and PTV (green) using the vaginal cylinder as shown on an axial and sagittal views of the CT images.

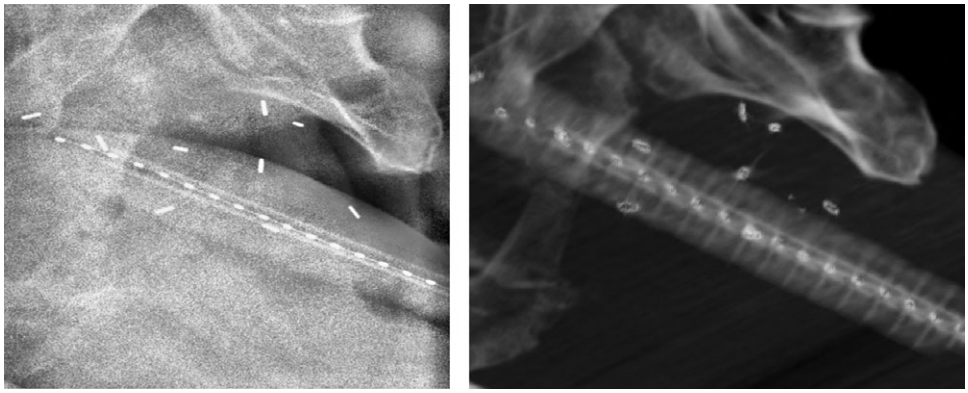

Figure 2. Radiographic image obtained from X-ray imaging system in the first column and digitally reconstructed radiograph in the second column by the ExacTrac system from the CT images.

1 missed fraction in the third week of treatment and a 6-day treatment interruption between fractions 20 and 21. She then began a protracted treatment interruption lasting 33 days during which she was removed from study participation, and an additional 23·4 Gy were prescribed to the residual primary area at 1·8 Gy per day using a four-field technique and three-dimensional planning (71 Gy total, a slightly increased dose to compensate somewhat for her treatment delay). She took an additional treatment break between fractions 29 and 30 for 3 and half weeks, finally completing 71 Gy to the primary in 41 fractions over 123 days.

Approximately 1 month later, she was seen by her referring gynaecologic oncologist with persistent pain at the primary site and a limited exam was suspicious for persistent disease. A repeat PET/CT was ordered and showed complete resolution of the nodal disease, but only a partial metabolic response at the primary site with a residual SUV of 15. Her case was discussed at the multidisciplinary gynaecologic oncology tumour board where a decision to offer palliative chemotherapy versus SABR versus hospice care was made. After conferring with the patient, she elected to have SABR in an attempt to achieve remission and possible cure.

Intolerant of examination, she was simulated under general anaesthesia after EUA and had additional fiducial marker placement at the periphery of the tumour. After patient alignment with the central axis laser of the CT simulator, a 25 mm Nucletron vaginal cylinder (Elekta AB, Stockholm, Sweden) was placed intra-vaginally, aligned vertically with the laser through its central axis and secured using a standard Nuclectron brachytherapy stabiliser board. Additional cylinder ring pieces from an identical cylinder were placed on the central rod for a total length of 17·5 cm in order for the cylinder to span the entire distance from the vaginal cuff to the introitus, vulva and beyond. The abdomen, pelvis and upper thighs were imaged at 2·5 mm slice thickness and the patient was awakened and discharged. Contouring of the tumour and avoidance structures was carried out in Eclipse (Varian Medical Systems, Palo Alto, CA, USA) as shown in Figure 1. Then, a stereotactic plan was generated to deliver 30 Gy in five fractions to the tumour with a 5 mm margin, subtracting the area of the planning target volume (PTV) that extended into the cylinder. A treatment plan with two arcs was made and delivered on a Varian TrueBeam SRS machine with 6X flattening filter-free beam. The planning images were sent to the BrainLab ExacTrac system (BrainLab, Munich, Germany) to aid in patient positioning at treatment.

This vaginal cylinder is made from non-metallic materials, which has made it compatible for X-ray radiography and CT imaging. The dummy seeds made from titanium in the inner channel of the cylinder showed well on the radiographs. All five treatment fractions were delivered under general anaesthesia. For each fraction, the patient was repositioned on the robotic couch with the central axis laser at midline and the vaginal cylinder was inserted and secured to the stabilisation board. AP and lateral kV radiographic images were acquired and the cylinder was repositioned to replicate in three axes as closely as possible to the original position at simulation as shown in Figure 2. The ExacTrac images were acquired using the vaginal cylinder as a surrogate to localise the nearby tumour. The patient was positioned with six degrees of freedom that included three translational shifts and three rotational shifts of the robotic couch. Then, a second set of ExacTrac images were acquired with the corrected patient

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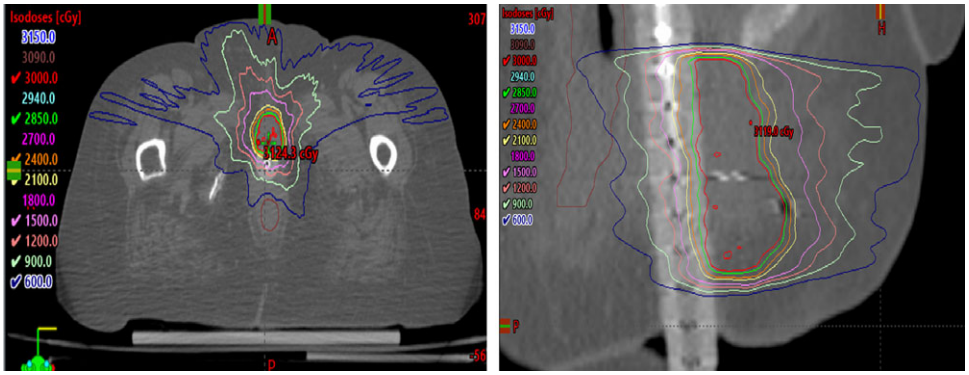

Figure 3. Dose distributions from the boost SABR plan with the vaginal cylinder to spare the rectum from excess dose.

position, confirming less than 1 mm and 1° deviation in all directions of the cylinder position for treatment from its initial position at the time of the simulation.

Results and Discussion

Vaginal examination at the conclusion of the fifth fraction showed near-complete involution of the tumour at the introitus. Oral narcotic analgesia between fractions and after treatment was necessary for patient comfort. The SABR plan delivered an additional 2.04 Gy mean dose to the rectum, with a maximum point dose of 10.4 Gy. The cumulative rectal dose for all treatment showed a maximum point dose of 74.57 Gy, a mean dose of 59.06 Gy, a 2 cc dose of 70.37 Gy and a 5 cc dose of 68.19 Gy as shown in Figure 3. Although higher than we would like, we felt these doses were acceptable given the surety of disease progression without treatment and the patient's ardent wish to achieve remission.

Retreatment of recurrent or persistent disease in the vagina is challenging because of the proximity of bladder, rectum, anus, urethra and clitoris. In this patient, the distal urethra and clitoris were involved and could not be spared, but the presence of the cylinder physically distanced the posterior vaginal wall and rectum/anus an additional 2.5 cm from the central axis of the SABR volume, allowing the delivery of a tumouricidal dose with diminished risk to the rectum, anus and posterior vaginal wall. Multichannel cylinder vaginal brachytherapy has been reported to accomplish similar ends for small volume disease that is not thicker than 5 mm in the vaginal wall, allowing asymmetric dose delivery to volumes of vaginal tissue with relative sparing of the rest of the organ.[13–15] However, this was not an option for our patient due to the size and thickness of her persistent tumour.

To our knowledge, this is the first report of a vaginal cylinder used to physically distance organs at risk from the treatment target, and also as a localising device for the delivery of SABR. This case is also illustrative of radiobiological principles of dose fractionation. Accelerated simultaneous integrated boost delivered sequentially to the involved nodes as prescribed during the initial period of compliance with treatment schedule was able to sterilise the involved nodes. Protracted and delayed treatment of the primary lesion allowed its persistence and required multiservice intervention, and demanded additional risk and manpower such as anaesthesia delivery and SABR.

Conclusion

Patients should be encouraged to adhere to timely delivery of their prescribed radiotherapy treatments, but we have reported here a novel approach to extirpating persistent disease in a non-compliant patient. This study demonstrated the successful use of a vaginal cylinder to achieve both goals of physically separating organs at risk from the PTV and employment of the cylinder as a localising device for accurate patient setup with image guidance in the delivery of SABR. This combination of external beam radiation therapies is an alternative and effective treatment option for patients who do not tolerate standard of care therapies.

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Conflict of interest. None.

References

1. Siegel R L, Miller K D, Jemal A. Cancer statistics, 2020. CA Cancer J Clin 2020; 70 (1): 7–30.
2. Ball H G, Berman M L. Management of primary vaginal carcinoma. Gynecol Oncol 1982; 14 (2): 154–163.
3. Gallup D G, Talledo O E, Shah K J, Hayes C. Invasive squamous cell carcinoma of the vagina: a 14-year study. Obstet Gynecol 1987; 69 (5): 782–785.
4. Stock R G, Chen A S, Seski J. A 30-year experience in the management of primary carcinoma of the vagina: analysis of prognostic factors and treatment modalities. Gynecol Oncol 1995; 56 (1): 45–52.
5. Rubin S C, Young J, Mikuta J J. Squamous carcinoma of the vagina: treatment, complications, and long-term follow-up. Gynecol Oncol 1985; 20 (3): 346–353.
6. Peters W A 3rd, Kumar N B, Morley G W. Carcinoma of the vagina. Factors influencing treatment outcome. Cancer 1985; 55 (4): 892–897.
7. Chyle V, Zagars G K, Wheeler J A, Wharton J T, Delclos L. Definitive radiotherapy for carcinoma of the vagina: outcome and prognostic factors. Int J Radiat Oncol Biol Phys 1996; 35 (5): 891–905.
8. Perez C A, Camel H M, Galakatos A E et al. Definitive irradiation in carcinoma of the vagina: long-term evaluation of results. Int J Radiat Oncol Biol Phys 1988; 15 (6): 1283–1290.
9. Davis K P, Stanhope C R, Garton G R, Atkinson E J, O'Brien P C. Invasive vaginal carcinoma: analysis of early-stage disease. Gynecol Oncol 1991; 42 (2): 131–136.
10. Otton G R, Nicklin J L, Dickie G J et al. Early-stage vaginal carcinoma–an analysis of 70 patients. Int J Gynecol Cancer 2004; 14 (2): 304–310.

https://doi.org/10.1017/S1460396921000169 Published online by Cambridge University Press

11. Amin MB (ed.). American Joint Commission on Cancer (AJCC) Staging Manual, 8th edition. Springer, 2017.
12. NRG-GY006 (n.d.). A Randomized Phase III Trial of Radiation Therapy and Cisplatin Alone or in Combination With Intravenous Triapine in Women With Newly Diagnosed Bulky Stage IB2, Stage II, IIIB, or IVA Cancer of the Uterine Cervix or Stage II-IVA Vaginal Cancer. Clinical Trials.govNCT#02466971
13. Glaser S M, Beriwal S. Brachytherapy for malignancies of the vagina in the 3D era. J Contemp Brachytherapy 2015; 7 (4): 312–318.
14. Vargo J A, Kim H, Houser C J et al. Image-based multichannel vaginal cylinder brachytherapy for vaginal cancer. Brachytherapy 2015; 14 (1): 9–15.
15. Beriwal S, Demanes D J, Erickson B et al. American Brachytherapy Society consensus guidelines for interstitial brachytherapy for vaginal cancer. Brachytherapy 2012; 11 (1): 68–75.

https://doi.org/10.1017/S1460396921000169 Published online by Cambridge University Press