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Very pronounced bowel sparing during radiation therapy for anal carcinoma using a natural spacer (Myoma) – a case report

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Abstract

Background Using dose-painted intensity-modulated radiation therapy, specific dose volume constraints or implantation of tissue expanders prior to radiotherapy are validated options for reducing radiation dose on the bowel and therefore minimizing acute gastrointestinal toxicity during chemoradiation for anorectal malignancies. We describe the rare case of a female patient with a locally advanced anal carcinoma where a large myomatous uterus served as a natural spacer to protect the bowel during radiation therapy.

Case presentation Initially the patient presented with anal pain, proctoscopy followed by an excisional biopsy confirmed the diagnosis of a squamous cell carcinoma of the anus. Imaging examination showed a locally advanced tumor and in addition a large uterus with typical leiomyomas up to 11.5 cm in diameter. The patient underwent chemoradiation; because of the large leiomyomas there was almost no dose burden for the small intestine and therefore practically no gastrointestinal toxicity.

Conclusion As we know, this report describes the situation that a large myomatous uterus served as a natural spacer during radiation therapy in a way that is unique to date.

Keywords Anal carcinoma, Bowel-sparing radiotherapy, Myomatous uterus, Myoma, Toxicity, Abdominal spacer

Background

A significant challenge during combined chemoradiation (CRT) for anal carcinoma is minimizing radiation-induced toxicity to surrounding organs, particularly the small and large bowel. Previous studies showed the effectiveness of dose-painted intensity-modulated radiation therapy (IMRT) in reducing acute gastrointestinal toxicity during CRT for anorectal malignancies [1–4]. It was also noted that specific dose-volume constraints may help to mitigate bowel toxicity [5]. In addition, some groups suggested the implantation of a tissue expander prior to radiation therapy (RT) to keep the bowel away from the target volume with the aim to reduce the risk of acute and late gastrointestinal toxicity [6]. Nevertheless, bowel exposure and acute and late bowel toxicity remains

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a challenge. This case report describes the dose-reducing effect of a naturally occurring large myomatous uterus, serving as a natural spacer.

Case presentation

We report a case of a 49-year-old female patient, who presented with anal pain. Proctoscopy showed an ulcerated lesion, an excisional biopsy confirmed the diagnosis of a squamous cell carcinoma of the anus. MRI and CT scans showed a locally advanced tumor without distant metastasis. Considering imaging and histopathologic results, tumor stage was pT2 cN0 cM0 G3 L0 V0 R1. Additionally, the images showed a large uterus with typical leiomyomas up to 11.5 cm in diameter (Fig. 1). These uterine leiomyomas were previously diagnosed by her gynecologist; hysterectomy was planned after CRT and confirmed complete remission of the anal carcinoma.

Intervention

The patient was treated with a total dose of 45 Gy in 25 fractions to elective nodal regions, including pelvic lymph nodes and 50 Gy to the primary tumour region as simultaneous integrated boost (SIB), delivered as volumetric modulated arc therapy (VMAT). The patient received 5-fluorouracil (5-FU) and mitomycin C concurrently with RT. Planning was based on CT and MRI scans. The myomatous uterus was contoured also based on the MRI imaging and was utilized as a natural spacer to increase the distance between the radiation fields and the bowel. Verification of positioning during RT was performed with image-guidance (IGRT) using daily cone-beam computed tomography (CBCT).

Dosimetric benefits

The presence of the myoma significantly reduced the radiation dose to the bowel – especially to the small bowel, as confirmed by dosimetric analysis (Fig. 2). Standard dose constraints for the small bowel typically aim to keep the volume of bowel receiving higher doses below a certain threshold (e.g. D_{max} 54 Gy and V45 < 150 cc for normofractionated RT). In this case, the Dose-volume-histogram (DVH) showed a marked reduction in the volume of small bowel receiving high-dose. The small bowel received a dose maximum of only 12.5 Gy, V45 = 8.2 cc and a mean dose of 0.7 Gy (Fig. 3).

The most important dose parameters are summarized in Table 1, including dose minimum (D_{min}), dose maximum (D_{max}) and mean dose (D_{mean}).

Treatment tolerance

The treatment was well tolerated. The patient developed manageable side effects, including bladder irritation and skin erythema. Correlating to the dosimetric benefits, the

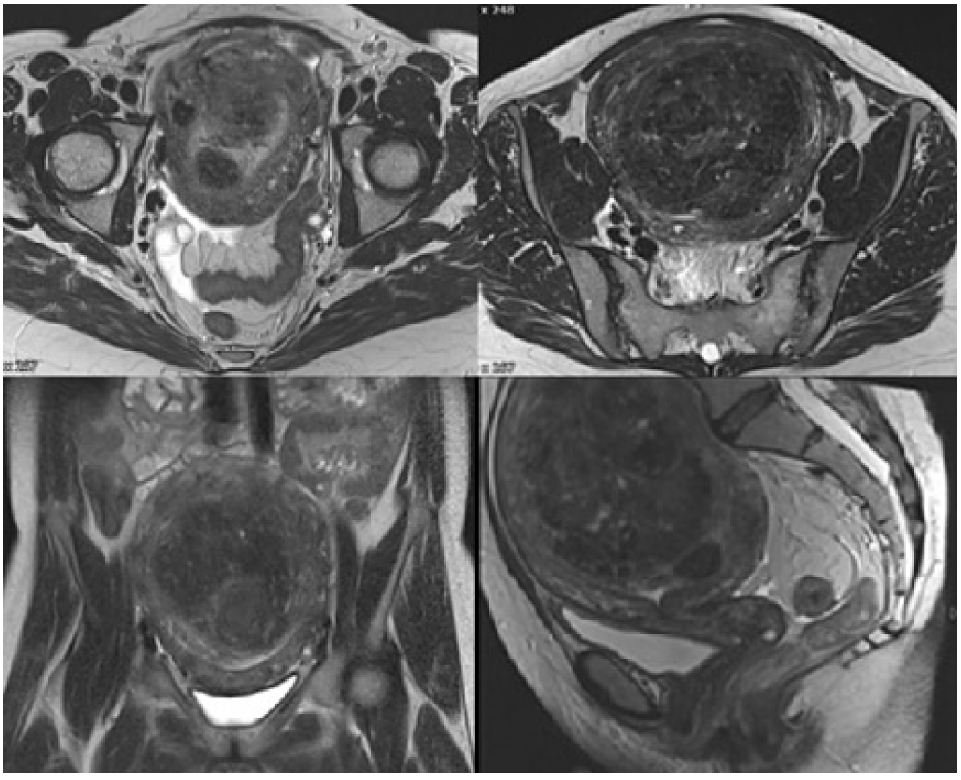

Fig. 1 MRI with large myomatous uterus

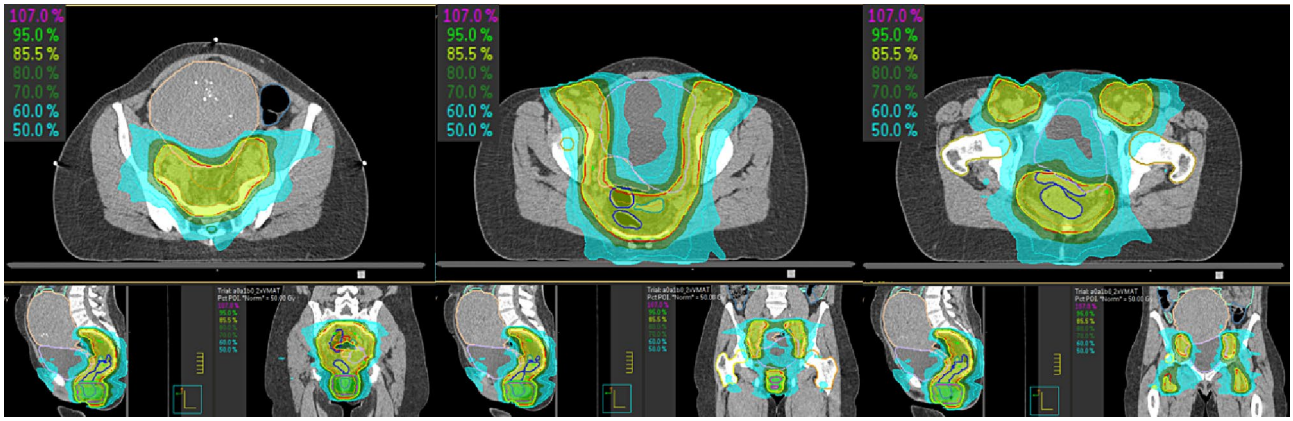

Fig. 2 Dose distribution in three representative slices (axial, coronal, sagital) for SIB (purple), PTV (red), CTV (orange), myoma (skin), bladder (lavender), colon (steelblue), femoral heads (yellow, orange), sigmoid colon (teal) and small bowel (aquamarine) with isodose lines (50% light blue, 60% light blue, 70% dark green, 80% dark green, 85.5% yellowgreen, 95% green, 107% purple)

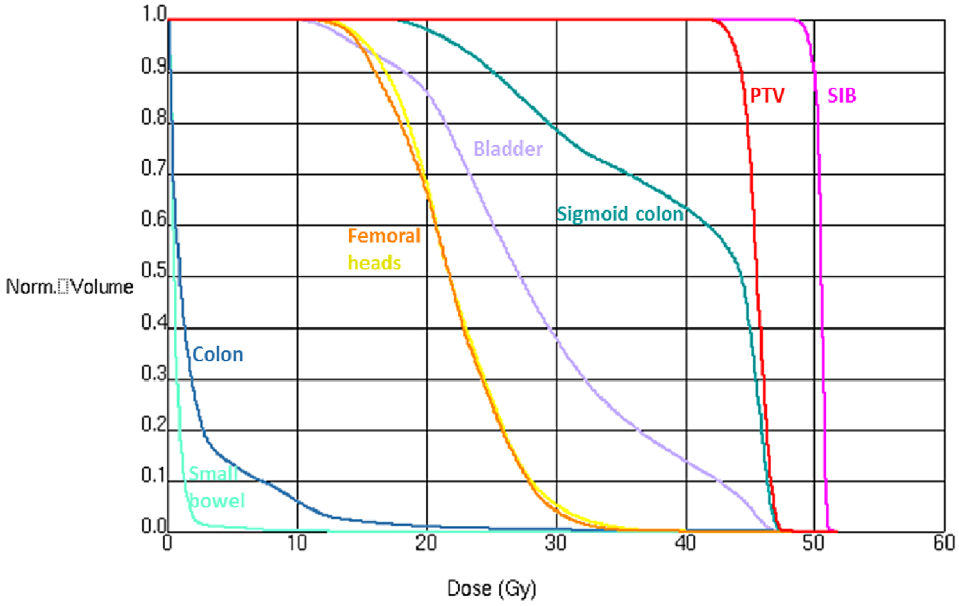

Fig. 3 Dose-volume histogram (DVH) of the investigated case for small bowel (aquamarine), colon (steelblue), femoral heads (left – orange, right – yellow), bladder (lavender), sigmoid colon (teal), PTV (red) and SIB (purple). X-axis shows the absolute dose in Gray (Gy). Y-axis shows the relative volume of the respective ROI in cubic centimeters (cc).

patient described no gastrointestinal side effects except of moderate rectal pain.

Discussion

Despite technological advances in radiotherapy treatment planning including intensity-modulated RT, volumetric-modulated RT, IGRT, online and offline adaptive RT approaches and charged particle therapy with protons and carbon ions, gastrointestinal toxicity remains a therapy-limiting issue for many indications [7–10]. In the past, some institutions successfully tried to overcome the gastrointestinal dose deposition in abdominal and pelvic radiotherapy with the surgical implantation of prosthetic, silastic, saline-filled tissue expanders [11–14]. A recent retrospective analysis on 29 children that received pelvic or abdominal RT after implantation of a silicone tissue-expander prosthesis (STEP) reports a reduced bowel dose over 40 Gy by 64% [12]. The 15-year complication-free survival of the irradiated long-term surviving children was 70%. However, the implantation itself represents an additional surgical procedure with foreign material with the potential of causing postoperative complications, repeat operations and a relevant delay of the planned RT treatment [6]. It is certainly very rare that an anatomical anomaly can lead to a significantly better dose distribution, especially in patients who are undergoing radiotherapy for anal carcinoma, which is more likely to have side effects.

ROI	D_{min} [Gy]	D_{max} [Gy]	D_{mean} [Gy]
Small bowel	/	12.53	0.72
Colon	/	25.72	2.28
Femoral head (left + right)	/	39.94	22.13
Bladder	/	47.52	28.47
Sigmoid colon	/	47.43	39.15
PTV	42.89	48.23	45.48
SIB	48.87	51.47	50.42

Table 1 Dose parameters in Gy for the in Fig. 3 shown region of interests

Taking our case as a starting point, various anatomical structures or abnormalities, if present, can be used as natural protectors in the case of high-dose radiotherapy. The use of appropriate diagnostic imaging can help in identifying and defining these structures or abnormalities.

Conclusion

Our report illustrates the unique opportunity of a large myomatous uterus to serve as a natural spacer to protect the bowel during RT for anal carcinoma. To our knowledge this report describes the rare situation that an anatomic/pathological anomaly exceptionally leads to a very advantageous dose distribution with almost no dose burden of the small intestine.

Abbreviations

5-FU	5-Fluorouracil
CBCT	Cone-Beam Computed Tomography
CC	Cubic Centimeters
CRT	Chemoradiotherap
CT	Computed Tomography
CTV	Clinical Target Volume
DVH	Dose-Volume-Histogram
Gy	Gray
IGRT	Image-Guided Radiotherapy
IMRT	Intensity-Modulated Radiation Therapy
MRI	Magnetic Resonance Imaging
PTV	Planning Target Volume
ROI	Region Of Interest
RT	Radiation Therapy
SIB	Simultaneous Integrated Boost
VMAT	Volumetric Modulated Arc Therapy

Author contributions

HL made substantial contributions to the conception, design, and drafting of the manuscript. EAK contributed significantly to data acquisition, analysis and revision of the manuscript. KGA contributed significantly to data acquisition and revision of the manuscript. ST contributed significantly to data acquisition and revision of the manuscript. AL contributed significantly to data acquisition and revision of the manuscript. HD contributed significantly to data acquisition, interpretation of data and drafting/ revision of the manuscript. All authors read and approved the final manuscript.

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Declarations

Consent for publication

Written informed consent was obtained from the patient for publication of this case. A copy of the written consent is available for review by the Editor in-Chief of this journal

Competing interests

The authors declare no competing interests.

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