Lymph Node Oligometastasis from Rectal Cancer in Contact with the Bowel Treated with High-Dose Planned Adaptive Radiotherapy

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Abstract

The efficacy of stereotactic ablative radiotherapy for oligometastases has been reported. However, there are no reports of oligometastatic lymph nodes in contact with the bowel being successfully treated with high-dose adaptive radiotherapy. A 61-year-old woman with oligometastatic pelvic lymph node after resection of rectal cancer was treated with high-dose planned adaptive radiotherapy using helical tomotherapy. Because the lymph node was in contact with the bowel, high-dose conventionally fractionated planned adaptive radiotherapy was used instead of stereotactic ablative radiotherapy to avoid bowel side effects such as perforation. Five years after radiotherapy, there is no recurrence and no adverse events. High-dose adaptive planned radiotherapy may become an alternative curative treatment for oligometastases in lymph nodes in contact with the bowel.

Keywords: *Rectal neoplasms, recurrence, image-guided radiotherapy, intensity-modulated radiotherapy, adverse effects.*

INTRODUCTION

Stereotactic ablative radiotherapy is a safe and effective curative treatment for lymph node metastases of rectal cancer [1]. However, if the recurrent lymph node is in contact with the bowel, an adequate dose of radiation may not be delivered due to the risk of gastrointestinal toxicity such as perforation [2, 3]. Adaptive radiation therapy modifies the treatment plan in response to changes in the shape and location of the tumor during radiotherapy [4]. By reducing the radiation field as the tumor shrinks, radiation exposure to normal tissues such as the bowel is reduced and higher doses of radiation are expected to be safely delivered to the tumor. However, there are no reports of solitary or oligometastatic lymph node recurrence after resection of rectal cancer successfully treated with adaptive radiotherapy. Here, we report a case of solitary pelvic lymph node metastasis in contact with the bowel that was successfully treated with high-dose planned adaptive radiotherapy using helical tomotherapy.

CASE REPORT

A 61-year-old woman was referred to our hospital for treatment of solitary metastasis of the right pelvic lymph node from rectal cancer. The patient had undergone laparoscopic resection of locally advanced upper rectal cancer (Stage IIIB, pT3 pN1 M0, AJCC 8th ed.) one year prior to referral. Pre- and postoperative chemotherapy or chemoradiotherapy were not used, as the patient refused. The postoperative course was uneventful, but regular serum carcinoembryonic antigen (CEA) levels increased (52.3 ng/mL, normal < 5 ng/mL) and whole-body F18-fluorodeoxyglucose (FDG) positron emission tomography (PET) / computed tomography (CT) revealed a solitary metastasis in the right pelvic lymph node. T2-weighted fast spin-echo MRI showed an enlarged hypointense obturator lymph node in contact with the bowel (**Fig. 1a**). The right obturator lymph node was hyperintense on diffusion-weighted imaging (DWI) (**Fig. 1b**) and T1 map (**Fig. 1c**). Post-gadolinium T1-weighted imaging showed heterogeneous enhancement with washout of gadolinium (**Fig. 1d**). Based on serum CEA levels, whole-body FDG-PET/CT, and MRI findings, a diagnosis of solitary metastasis to the right obturator lymph node from rectal cancer was made. We initially attempted stereotactic ablative radiotherapy, but because the lymph node was in contact with the bowel and there was concern for gastrointestinal toxicity such as perforation, conventionally fractionated high-dose adaptive radiotherapy with helical tomotherapy was performed.

Radiotherapy Treatment Planning

All treatments were performed in strict accordance with the ethical standards established by institutional and national research committees. In addition, the procedures outlined in the Declaration of Helsinki of 1964 and its subsequent amendments ensured the ethical treatment of the participants. The treatment protocol was approved by the institutional review board of our institution (RO2018112). Written informed consent was obtained from the patient for publication of her clinical data. The consent process was conducted in accordance with established ethical guidelines. The patient underwent both CT and MRI simulation, and we used a Vac-Lok cushion as an immobilization system. We used non-contrast transverse CT scans with a slice thickness of 2.5 mm for target volume delineation and dose calculation. We also used T2-weighted fast spin-echo MRI to delineate the gross tumor volume (GTV) and adjacent bowel. The planning target volume (PTV) was

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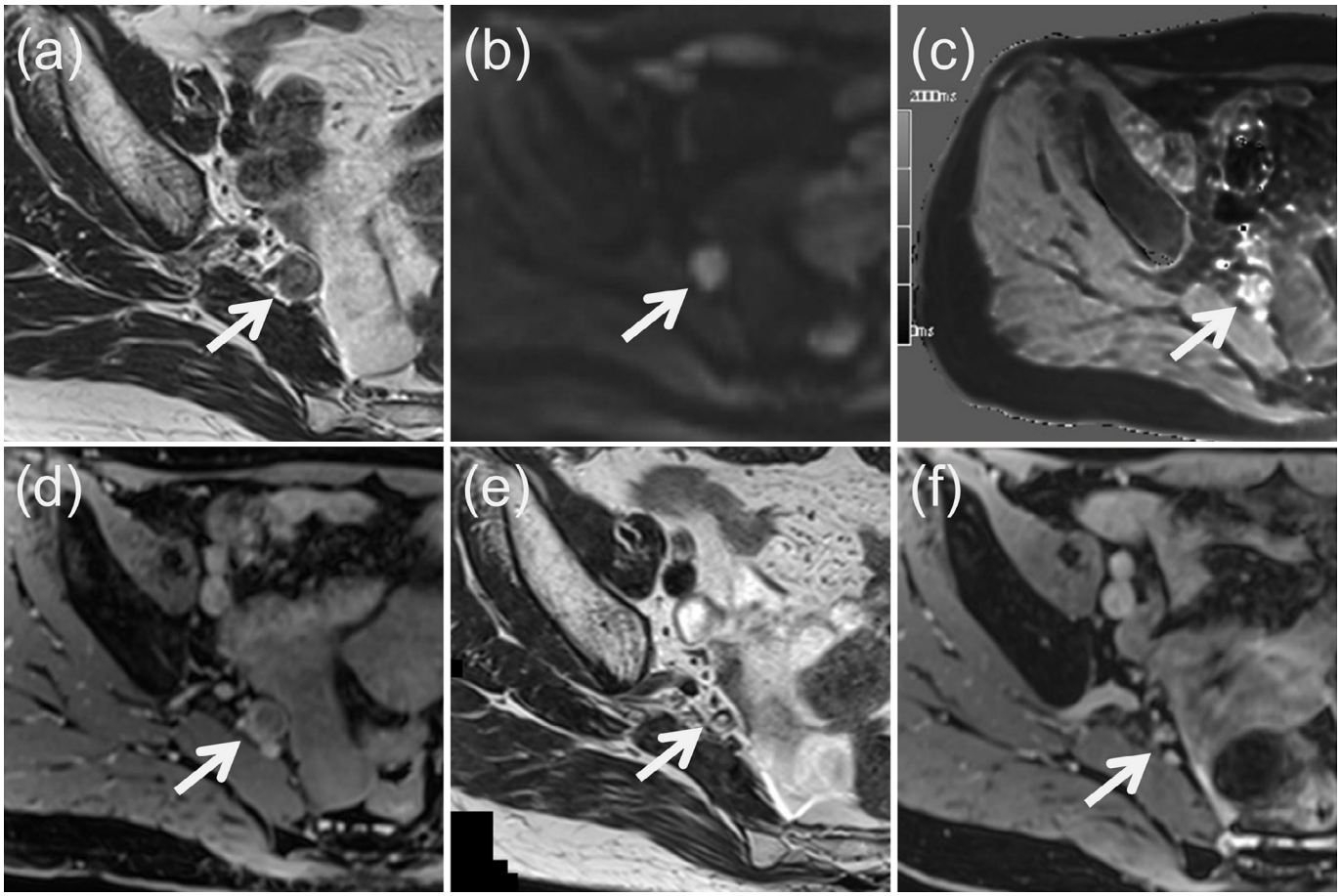

Fig. (1): MRI before and after adaptive radiotherapy. **(a)** T2-weighted fast spin-echo imaging showed an enlarged hypointense obturator lymph node (arrow) in contact with the bowel. **(b)** Diffusion-weighted imaging with a b-value of 800 s/mm^2 showed that the right obturator lymph node was hyperintense (arrow). **(c)** The lesion was hyperintense on the T1 map (arrow). **(d)** Post-gadolinium T1-weighted imaging showed heterogeneous enhancement with washout of gadolinium (arrow). **(e)** T2-weighted fast spin-echo imaging 6 months after adaptive radiotherapy showed no lymph node enlargement (arrow). **(f)** Post-gadolinium T1-weighted imaging showed no metastatic lymph nodes (arrow).

created by adding 2 to 3 mm three-dimensional margins to the GTV, but excluding the bowel. The prescribed dose for PTV was 77.7 Gy in 37 fractions (**Fig. 2a-c**), and treatment was delivered using helical tomotherapy (Accuray, Madison, Wisconsin, United States). The dose was defined as the minimum dose received by 95% of the volume (D95%). Immediately after completion of the 48.3 Gy, 23rd fraction, an adaptive treatment plan was created in the same manner as the initial treatment plan. The maximum allowable dose to 1cc (D1cc) of the bowel was set at 74 Gy. Both the initial and adaptive treatment plans were designed to prioritize compliance with the bowel dose limit over the prescribed dose to the PTV.

Post-Treatment Course

There were no adverse events during radiotherapy or at follow-up. Chemotherapy after radiotherapy was not administered due to patient's refusal. Follow-up MRI showed a complete response of the right obturator lymph node (**Fig. 1e and f**) 6 months after treatment.

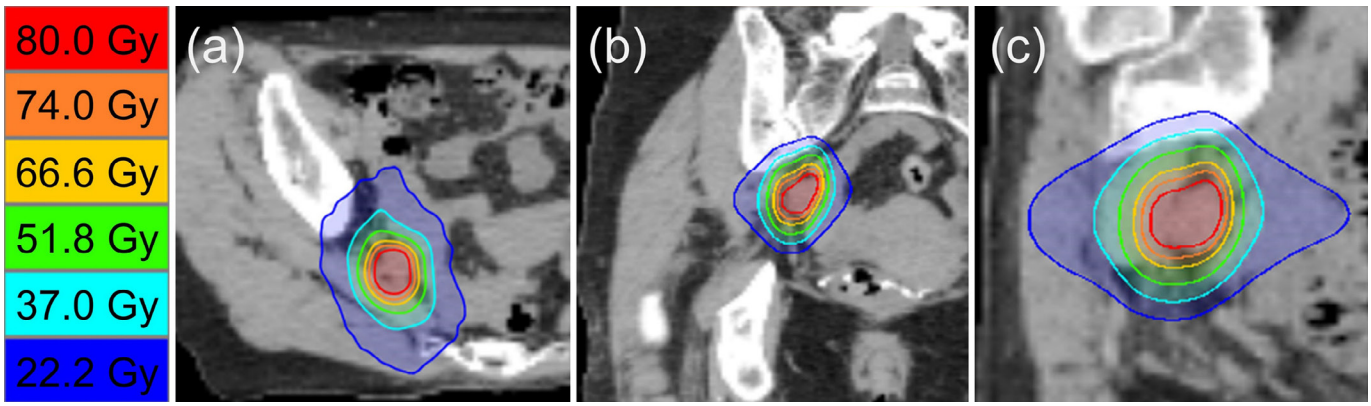

Fig. (2): Isodose distributions for high-dose adaptive radiotherapy. **(a)** Transverse. **(b)** Coronal. **(c)** Sagittal.

Five years after high-dose adaptive radiotherapy, there is no recurrence without chemotherapy or immunotherapy and no adverse events.

DISCUSSION

New Applications of Adaptive Radiotherapy

To our knowledge, this is the first report of solitary pelvic lymph node metastasis from rectal cancer in contact with the bowel successfully treated with high-dose planned adaptive radiotherapy. In general, stereotactic ablative radiotherapy and heavy ion therapy are not indicated when metastatic lymph nodes are in contact with the bowel because of the high risk of bowel toxicity such as perforation [1-5]. Although there are several case reports of high-dose adaptive radiotherapy under MRI guidance for pancreatic tail cancer adjacent to the colon [6] and liver metastases adjacent to the bowel [7], there are no reports of similar treatment using helical tomotherapy. This case report suggests that the planned adaptive radiotherapy technique may allow metastatic lymph nodes to shrink during radiotherapy and ultimately allow safe delivery of high doses of radiation.

Advantages of Planned Adaptive Radiotherapy

This case report has several advantages. First, by reducing each fractionated dose to 2-2.1 Gy, we believe it is safer to deliver than stereotactic ablative radiotherapy in the event of unexpected body movements and bowel peristalsis. Second, when metastases develop in the pelvic lymph nodes after surgery for rectal cancer, systemic treatment is the standard of care, but cure is not expected. In addition, there is no effective treatment for patients who are unable or unwilling to take systemic therapy. However, in the case of a single metastasis or oligometastasis, as in the present case, even if the metastasis develops in a lymph node adjacent to the intestinal tract, cure can be expected without surgery, chemotherapy or immunotherapy.

Limitations of Planned Adaptive Radiotherapy

This case report has several limitations. First, it takes up to seven weeks to complete a full course of radiation therapy. Long-term treatment is physically and emotionally demanding for a patient, but it seems acceptable if the patient wants it and if there are no significant obstacles in his or her general condition, since it is aimed at curing the disease. Second, the optimal dose and number of fractions have not been determined, nor has the concomitant use of chemotherapy or immunotherapy. Further studies will justify the safe and effective use of high-dose adaptive radiotherapy.

CONCLUSION

In conclusions, a single case report cannot be generalized to other cases without further scientific verification; however, high-dose planned adaptive radiotherapy using helical tomotherapy may become a safe and effective treatment option for single or oligometastases of rectal cancer to the regional lymph nodes adjacent to the bowel.

CONSENT FOR PUBLICATION

The authors declare that this work does not contain personal information that could lead to patient identification. In addition, informed consent was obtained from the patient for publication of her clinical data and is held by the authors.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

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