Clinical Radiology 69 (2014) 1273–1279

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.clinicalradiologyonline.net

MRI findings of radiation-induced myocardial damage in patients with oesophageal cancer

R. Umezawa [a,*], H. Ota [b], K. Takanami [b], A. Ichinose [b], H. Matsushita [a], H. Saito [c], K. Takase [b], K. Jingu [a]

[a] Department of Radiation Oncology, Tohoku University School of Medicine, Sendai, Japan
[b] Department of Diagnostic Radiology, Tohoku University School of Medicine, Sendai, Japan
[c] Department of Diagnostic Image Analysis, Tohoku University Graduate School of Medicine, Sendai, Japan

ARTICLE INFORMATION

Article history:
Received 21 June 2014
Received in revised form
21 June 2014
Accepted 12 August 2014

AIM: To evaluate radiation-induced myocardial damage after mediastinal radiotherapy using MRI.

MATERIALS AND METHODS: Between May 2010 and April 2011, delayed contrast-enhanced MRI was performed for patients who had maintained a complete response to curative radiotherapy for oesophageal cancer for more than 6 months. The patients received radiotherapy with a median total dose of 66 Gy (60–70 Gy) for the primary tumour and metastatic lymph nodes. Images of MRI were analysed by a 17-segment method recommended by the American Heart Association. A segment included mainly in the 40 Gy dose line was defined as Segment 40 Gy, a segment included mainly in the 60 Gy dose line as Segment 60 Gy, and a segment out of the radiation fields as Segment OUT. The percentage of late gadolinium enhancement (LGE) was examined in those categories. The layer in which LGE was predominantly distributed was evaluated for each patient.

RESULTS: Four hundred and eight segments in 24 patients were analysed. The median interval from completion of radiotherapy to MRI was 23.5 months (range 6–88 months). LGE was detected in 12 of the 24 patients. LGE was detected in 15.38% of Segment 40 Gy cases, 21.21% of Segment 60 Gy cases, and 0% of Segment OUT cases. LGE in mid-myocardial and subendocardial layers was detected in 11 patients and one patient, respectively.

CONCLUSION: LGE suggesting radiation induced myocardial fibrosis was observed by performing delayed contrast-enhanced MRI. Care should be taken when planning radiotherapy to avoid late cardiac damage.

Introduction

Outcomes of mediastinal radiotherapy for malignant diseases, such as Hodgkin's lymphoma and oesophageal cancer, have been improved, but radiation induced cardiac disease remains a concern.[1–3] Therefore, long-term survivors who have received mediastinal radiotherapy should be carefully observed for the potential risk of late cardiac damage if the heart was included in the radiation fields.

In some past studies, radiation induced myocardial damage was evaluated using myocardial scintigraphy. Scintigraphy using 99m technetium (Tc-99m) sestamibi, Tc-99m tetrofosmin, or thallium-201 demonstrated

* Guarantor and correspondent: R.Umezawa, Department of Radiation Oncology, Tohoku University School of Medicine, 1-1, Seiryou-machi, Aobaku, Sendai, 980-8574, Japan. Tel.: +81 22 717 7312; fax: +81 22 717 7316.
E-mail address: reirei513@hotmail.com (R. Umezawa).

http://dx.doi.org/10.1016/j.crad.2014.08.010
0009-9260/

myocardial perfusion defects in the radiation fields of some patients who had been treated for left breast cancer or oesophageal cancer.[4–6]

Late gadolinium enhancement (LGE) MRI enables visualization of the myocardial scar in patients with ischaemic and non-ischaemic myocardial diseases.[7,8] LGE-MRI has higher spatial resolution than that of scintigraphy and visualizes lesions in myocardial layers.[9] Therefore, MRI may provide more detailed information about radiation induced myocardial damage.

To the author's knowledge, there have been few reports on evaluation of radiation induced myocardial damage using MRI.[10] The purpose of the present study was to examine myocardial damage corresponding to radiation fields in patients with oesophageal cancer using LGE-MRI.

Materials and methods

Patients

Patients who had maintained complete response to curative radiotherapy for oesophageal cancer for more than 6 months were included and underwent MRI between May 2010 and April 2011. This study was approved by a local institutional review board, and all of the patients gave written informed consent before enrolment.

Radiotherapy

Radiotherapy was mainly delivered using photon beams using 10 MV equipment with a multiple leaf collimator. The daily fractional dose of radiotherapy was 2 Gy, administered 5 days per week. The gross tumour volume was defined as the primary tumour and metastatic lymph nodes. The initial clinical target volume (CTV) included prophylactically the region from the supraclavicular to coeliac lymph nodes. This region received 40 Gy using parallel-opposed anterior–posterior fields. The boost CTV included the primary tumour with a 20–30 mm craniocaudal margin and an approximately 5 mm radial margin and metastatic lymph nodes. This region received 20–30 Gy using parallel-oblique fields to avoid the spinal cord. The planning target volume (PTV) was defined as the CTV plus a 5–15 mm margin. The total dose was 60–70 Gy (median dose, 66 Gy). As shown in Fig 1, a part of the left ventricle was included in the radiation fields. In consideration of their performance state and age, radiation fields were kept small (for example, by restricting supraclavicular lymph nodes). Treatment planning was performed using CT in all patients, and the

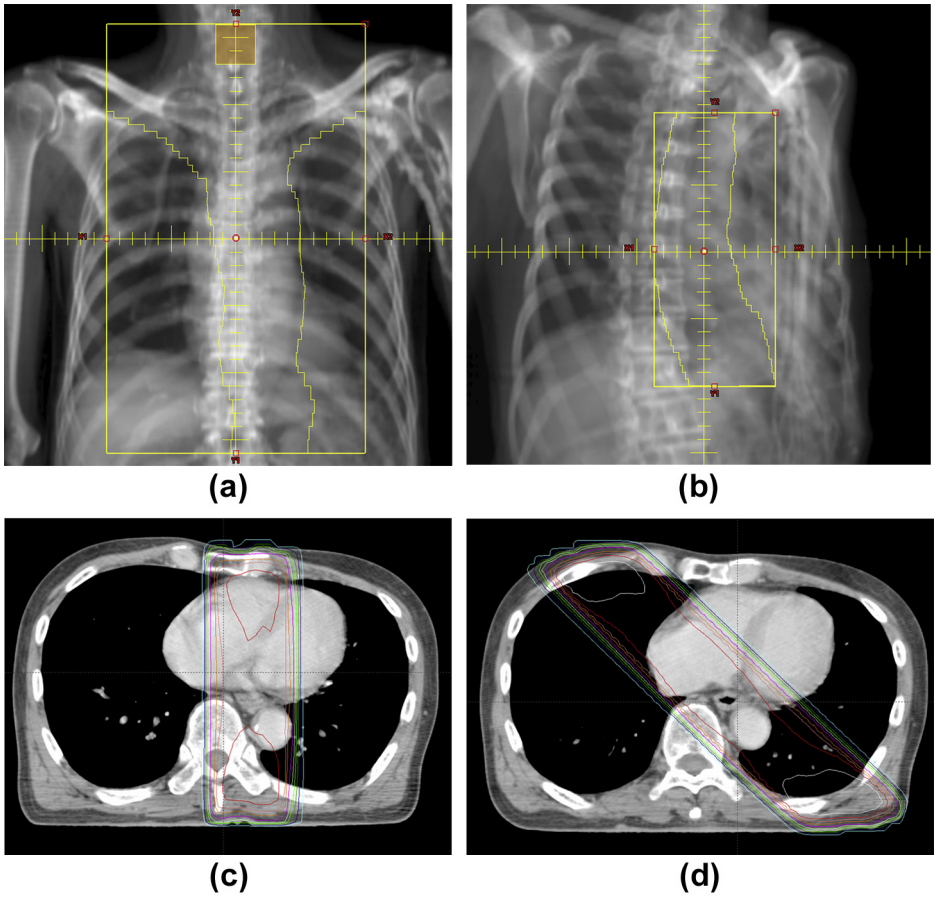

Figure 1 Main radiation fields and dose distributions. (a, b) Irradiation was performed with 40 Gy using anterior–posterior fields. (c, d) Irradiation was performed with 20 Gy to 30 Gy using parallel-oblique fields to avoid the spinal cord.