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CT and MRI of radiation-induced sarcomas of the head and neck following radiotherapy for nasopharyngeal carcinoma

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AIM: To investigate the radiological findings of head and neck radiation-induced sarcomas (RISs) following radiotherapy for nasopharyngeal carcinoma (NPC).

MATERIALS AND METHODS: Fifty-nine patients with RISs were identified. Imaging characteristics on computed tomography (CT) and magnetic resonance imaging (MRI), including lesion location, extent, size, margin, internal architecture, pattern, and degree of enhancement, together with patient characteristics at NPC diagnosis and latency periods, were reviewed.

RESULTS: The study included 20 women and 39 men, with a median age of 49 years (range 30–71 years). The median latency was 9 years (range 3–37 years). The median radiation dose at the site of RIS was 66 Gy (range 44–78 Gy). The most common histological RIS types were fibrosarcoma (44.1%) and osteosarcoma (30.5%). The most common RIS sites were the paranasal sinuses and the nasal cavity (39%), the neck (16.9%), and the mandible (15.3%). The mean size was 5.1 cm (range 1.2–8.6 cm). Overall, 78% of lesions extended to adjacent spaces and 66.1% were accompanied by bone destruction. Heterogeneous density/signal intensity before and after enhancement was seen in all lesions on imaging. Marked lesion enhancement was noted in 49 cases (76.3%).

CONCLUSIONS: The radiologist should be aware of the different sites at which RISs occur and the radiological appearance of the wide variety of RIS subtypes. Careful imaging follow-up is necessary for early detection of RISs in patients with NPC after radiotherapy.

Introduction

Radiotherapy is the main treatment modality for nasopharyngeal carcinoma (NPC), which is a common tumour in the southern Chinese population. However, ionizing radiation is itself a known carcinogen, and sarcomas can be a complication of treatment.[1] Radiation-induced sarcomas (RISs) in the head and neck are particularly rare, with a reported incidence in adults ranging from 0.03–0.8%.[2,3] To the authors' knowledge, the earliest description of RIS was

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Table 1
Patient characteristics at nasopharyngeal carcinoma diagnosis ($n = 59$).

Characteristic	No. of patients	%
Sex		
Men	39	66.1
Women	20	33.9
Age at diagnosis, yr		
≤30	9	15.3
>30	50	84.7
TNM stage		
I/II	45	76.3
III/IV	14	23.7
Histological type		
WHO type III	59	100
WHO type I and II	0	0
Radiation technique		
Conventional radiotherapy	59	100
IMRT	0	0
Neoadjuvant chemotherapy		
Yes	5	8.5
No	54	91.5

WHO, World Health Organization; IMRT, intensity-modulated radiotherapy.

reported in 1922.[4] Reports detailing RISs are common in patients with breast cancer, lymphoma, pelvic cancer, or Ewing's sarcoma,[5,6] but there have been relatively few reports in patients with NPC. Imaging studies of RIS in patients with NPC have been limited to case reports and relatively small case series.[7,8] The present series included 59 patients, which is a relatively large series. Although RIS is rare, more and more radiation-induced tumours appear in areas where NPC is endemic. Thus, studies of RISs are of increasing importance. The objectives of the present study were to review computed tomography (CT) and magnetic resonance imaging (MRI) findings, and to analyse the clinicopathological characteristics of a relatively large group of patients who developed RIS after radiotherapy for NPC in Sun Yat-sen University Cancer Center.

Materials and methods

Patients

The institutional review board approved this retrospective study. Data were retrospectively collected from the medical records of patients who developed RIS after radiotherapy for NPC (22,386 cases) at Sun Yat-sen University Cancer Center between January 2000 and December 2011. Eligibility for the study was based on the criteria for RIS published by Cahan et al.[1] and modified by Arlen et al.[9]: (1) a prior history of radiotherapy; (2) the occurrence of sarcoma within the previously irradiated field; (3) histological confirmation of the sarcomatous nature of the lesion; and (4) latency between irradiation and a second primary sarcoma ≥3 years. Cases of RIS but without CT or MRI were excluded.

Imaging techniques

The scan range of CT and MRI was from skull base to clavicles. Thirty-four patients underwent CT with a Brilliance TM16 (Philips Medical Systems, Best, The Netherlands) or a Toshiba Aquilion TM64 (Toshiba Medical Systems, Otawara, Japan) helical CT system. The main imaging parameters were as follows: 5 mm section thickness reconstructions, 25 cm field of view, 120 kV tube voltage, 250–300 mA current, and 512 × 512 matrix. An intravenous bolus dose of 90 ml non-ionic iodinated contrast agent (iopromide; Ultravist, Schering, Berlin, Germany) was administered at a rate of 3 ml/s.

Twenty-five patients underwent MRI with a 1.5 T system (Signa CV/i; GE Healthcare, Milwaukee, WI, USA) or a 3 T system (Trio Tim; Siemens Medical Solutions, Erlangen, Germany) by employing a spin-echo technique with a head and neck combined coil. T1-weighted images in the axial, coronal, and sagittal planes, and T2-weighted images in the axial plane were obtained before injection of the contrast material. After intravenous injection of gadopentetate dimeglumine (Magnevist; Bayer Schering Pharma, Berlin, Germany) at a dose of 0.1 mmol/kg of body weight, T1-weighted fat-suppressed axial, coronal, and sagittal sequences were performed sequentially, with parameters similar to those used pre-injection. The section thicknesses and intersection gaps were, respectively, 5 mm and 1 mm for the axial plane and 6 mm and 1 mm for the coronal and sagittal planes.

Table 2
Clinical and computed tomography/magnetic resonance imaging findings in 59 radiation-induced sarcomas.

Histology	No.	%	M	F	Median age (years)	Latency (years)	Site[a]	Mean size (cm)
Fibrosarcoma	26	44.1	19	7	48.5	9.5	Paranasal sinuses and nasal cavity	5.1
Osteosarcoma	18	30.5	11	7	54	10.5	Mandible	5.4
MFH	10	16.9	7	3	45	6.5	Maxillary sinus	5.5
Neurofibrosarcoma	1	1.7	1		52	4	Preauricular	1.2
Carcinosarcoma	1	1.7		1	51	8	Gingiva	2.1
Chondrosarcoma	1	1.7		1	41	5	Sphenoid sinus	5.8
Meningeal sarcoma	1	1.7	1		37	8	Cerebellopontine angle	4.5
LGMS	1	1.7		1	62	10	Maxillary sinus	5.1

M, male; F, female, MFH, malignant fibrous histiocytoma; LGMS, low-grade myofibroblastic sarcoma; No., No. of patients; BD, associated bone destruction; SI, signal intensity; Het, heterogeneous; Hom, homogeneous.
[a] The most common site.