

Radiation Response Assessment by Hybrid Positron Emission Tomography/Magnetic Resonance Imaging for Head & Neck Cancers

Ivan Tham^{1,2}, Jianhua Yan¹, Thian C Ng¹, Dennis Cheong¹, Sharmili Roy¹, John Totman¹,

Lih Kin Khor³, Julian Goh⁴, David Townsend¹

1. A*STAR-NUS, Clinical Imaging Research Centre, Singapore
2. Department of Radiation Oncology, National University Cancer Institute, Singapore
3. Department of Diagnostic Imaging, National University Hospital, Singapore
4. Department of Diagnostic Radiology, Tan Tock Seng Hospital, Singapore



Background

Locoregional failure after radical radiation therapy (RT) can occur in a significant minority of patients. Typically, treatment response is assessed months after RT due to confounding acute RT effects. We hypothesise that hybrid positron emission tomography (PET)/magnetic resonance imaging (MRI) is able to visualize early tumour changes even during RT, & could potentially provide actionable information for treatment modification prior to the completion of standard of care.

Patients and Methods

After informed consent, patients underwent a PET/MRI scan with a Siemens Biograph mMR at baseline, weeks 2, 4 and 6 of the RT course, then 3 months post-treatment.



Figure 1: Siemens Biograph mMR

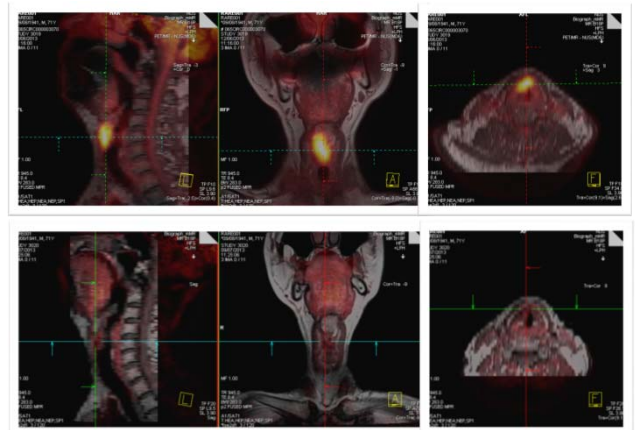
Six mCi of 18F-FDG was used for the initial scan and 3mCi was used for subsequent scans. Multiple MRI sequences were utilized through three planes, including T1, T2, DIXON & DWI/ADC sequences, for attenuation correction & structural localization. Dynamic contrast enhancement MRI was also performed. Standard of care was delivered regardless of scan results. Standard clinical follow-up was adopted after study completion.

Results

Patient Characteristics	
Age Range	36 - 71
Male	3
Female	1
Site	Larynx 1 Oral cavity 1 Nasopharynx 2
Histology	Squamous cell carcinoma 2 Undifferentiated carcinoma 2
Radiation therapy dose	69.96 Gy/ 33F/ 6.5 wks

Table 1: Patient Characteristics

All showed good radiological response to treatment on both PET and MRI, with the largest change seen typically between the baseline and first treatment scan (week 2). One had an increase in MRI ROI volume after RT started but this trended down as treatment continued. All attained complete radiological response at 3 months post-treatment. To date, there are no clinical locoregional recurrences. One has developed distant metastases.



Sagittal, coronal & axial sections of patient at baseline (Figure 2a, above) and 30 Gy (Figure 2b, below) of concurrent chemoradiation therapy showing near complete response at laryngeal primary site

Patient	ROI*	MRI Tumour volumes/cm ³				
		Baseline	Time-point 2	Time-point 3	Time-point 4	Time-point 5
1	Primary	6.955	2.144	2.278		0
2	Primary	11.40	10.03	7.635	7.023	5.090
	Node	19.39	12.86	5.464	4.209	2.454
3	Primary	35.27	23.08	10.87		7.156
4	Primary	5.497	4.203	1.821		1.127

*ROI; region of interest

Table 2: Tumour volumes as measured by MRI with contrast

Summary PET characteristics	Range
Metabolic Volume	4.7 – 11.5 cm ³
SUV _{max}	10.2 – 16.1
SUV _{mean}	5.8 – 9.5

Table 3: Summary PET data

Conclusions

Significant treatment response to RT can be detected early using PET/MRI, typically by week 2 – 3 of RT. We plan to confirm this finding with further quantitative analysis by increasing the patient accrual. These findings may allow for personalized treatment in future based on early tumour response.