Dynamic Contrast Enhanced (DCE) MRI Metrices as a Predictor of Response in Head and Neck Cancers

S. Agrawal[1], R. Awasthi[2], A. Singh[3], R. K. Rathore[3], and R. K. Gupta[2]

[1]Department of Radiotherapy, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India, [2]Department of Radiodiagnosis, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India, [3]Department of Mathematics and statistics, Indian institute of technology, Kanpur, Uttar Pradesh, India

Introduction: Head and neck cancers are the commonest cancers amongst males in India with an age adjusted incidence rate of 20.5 to 49.5 per 1, 00,000 population (National Cancer Registry Programme 2001-2002). These patients are usually unresectable and therefore best managed with chemoradiation . Locoregional relapse following aggressive chemoradiotherapy for advanced head and neck cancer remains a significant clinical problem. Explanations for locoregional failure are intrinsic radioresistance, hypoxic cell resistance and repopulation of resistant tumor clonogens .Although staging and other clinical–pathologic variables provide some prognostic information, there is clearly a need to identify better prognostic markers, which can help to identify which patients are at risk of local, regional or distant relapse. Oxygenation is an important predictor of response of tumor cells to radiation and vasculature is an important feature of drug delivery in chemotherapy. In vivo levels of oxygenation correlate with local control when treated with radiotherapy. Tumor blood flow is thus an important parameter in predicting outcome from treatment with radiotherapy. Tumor blood flow can be imaged and quantitatively assessed using dynamic MRI. Because of its superior contrast between tumor and normal tissue, dynamic MRI also detects small lesions such as residual tumors after radiotherapy.

Materials and Methods: Twenty one patients of squamous cell carcinomas of head and neck underwent DCE imaging prior to radiotherapy . DCE MR imaging was performed using a three dimensional spoiled gradient recalled echo (3D-SPGR) sequence. The data was processed using in-house developed JAVA based perfusion software. Voxel wise tissue T10 was calculated from T1, T2 and PD weighted images obtained using FSE sequences. The absolute tissue T10 value was used to generate concentration time curve from signal intensity-time curve obtained from 3D-SPGR sequence. Quantitative analysis of concentration time curve was performed for calculation of TBV(tissue blood volume) and TBF (tissue blood flow) .Pharmacokinetic model was implemented for ktrans and ve calculation . Patients were then treated by chemoradiotherapy as per the standard protocol in our department. Response assessment was done at 6 weeks of completion of radiotherapy. The DCE MRI parameters in terms of tissue blood flow(TBF), tissue blood volume (TBV), corrected TBV, bolus arrival time (BAT) and β were correlated with T,N, stage group of the patient and with response to treatment.

Results: Out of 21 patients,nine patients had squamous cell cancers of oropharynx,six had squamous cell cancers of oral cavity, four had squamous cell cancers of hypopharynx and two had squamous cell cancers of middle ear. Except one patient with stage II disease, rest had locally advanced disease (stages III (n=7), and stage IV (n=13)).TBF, TBV and corrected TBV were higher for higher T stage, but not for N stage, and overall stage group (Table1). BAT and β did not differ for varying T, N, and overall stage of patients. TBF, TBV and corrected TBV were higher for complete responders than partial responders at both primary and nodes (Table2).These parameters were higher even for complete responders if overall response was taken into account (Table2). The difference in TBF, TBV, and corrected TBV between the complete and partial responders at primary was 14.61, 11.27 and 11.10 (p value 0.35, 0.50, 0.51 respectively). The difference in TBF, TBV, corrected TBV between the complete and partial responders at secondary was 14.61, 11.27 and 11.10 (p value 0.49, 0.52, and 0.53 respectively).The difference in TBF, TBV, corrected TBV between the complete and partial responders for overall response was 14.61, 11.27 and 11.10 (p value 0.35, 0.50, and 0.51 respectively).

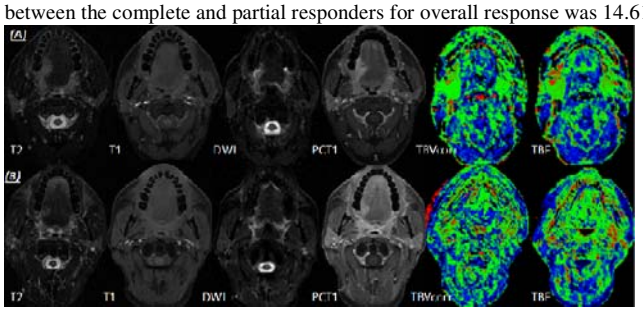

Figure 1: T2, T1, DWI, Post-contrast T1, TBVcorrected map, TBF map of a patient with Ca tongue; (A) before radiotherapy, (B) after radiotherapy

Response	TBF	TBV	Corr TBV
Primary			
CR	25.61±20.60	21.73±20.45	22.36±20.26
PR	11.00±3.25	10.46±4.40	11.26±5.05
Nodes			
CR	20.18±18.09	21.17±19.95	21.54±19.98
PR	9.41±4.04	10.29±3.32	11.07±3.85
Overall response			
CR	25.61±10.09	21.73±20.15	22.36±20.41
PR	10.99±3.25	10.46±4.40	11.26±5.05

Table 2: DCE parameters according to response.

stage	TBF	TBV	Corrected TBV
T2	9.34±8.05	9.57±9.09	10.5±10.14
T3	17.18±8.93	11.98±1.28	13.28±2.23
T4	16.7±16.04	16.6±15.90	17.38±16.03
N0	16.24±7.04	10.9±5.70	12.01±6.07
N1	28.48±21.04	30.4±25.46	31.13±25.02
N2	6.49±4.04	6.8±4.50	7.41±5.18
N3	12.34±0.01	12.4±0.01	13.35±0.01
Stage II	15.1±0.01	16.5±0.01	18.6±0.01
Stage III	13.78±9.04	9.6±4.08	10.5±5.75
Stage IV	16.7±15.40	16.6±15.9	17.00±15.94

Table 1: DCE parameters according to presenting stage of patients

Discussion: The aim of this study was to evaluate the utility of DCE MRI as a predictor of response in head and neck cancers. Pretreatment DCE MRI parameters like TBF, TBV and corrected TBV can be used as a predictor of response to treatment since these values are larger in responders than nonresponders. This could be explained by a better blood supply to the tumours (therefore less hypoxia) resulting in a better response.This observation concurs with experimental data of a better response in well perfused tumours. DCE MRI parameters at completion of radiotherapy have been seen to predict response in patients of head and neck cancer.(1) Local control after radiotherapy in head and neck cancers has been related to a perfusion >80ml/100gm/min which is similar to our study.(2) Not much of data is available on DCE MRI in head and neck cancers because of the lack of an appropriate software to analyse DCE MRI parameters.**Conclusion:** Our study reflects TBF and TBV as predictors of outcome in head and neck cancer patients but needs validation in more patients to get a more robust conclusion.

References:

1. Joskins et al. *BJR* 1999;72:1093-1098.
2. Singh et al. *J Magn Reson Imaging* 2007;26:871-880.