Overall, the possibility of sparing the bowel at the cost of extra dose to the bladder and vice versa was demonstrated. The estimated change in primary tumor control for high versus low dose regimen was less than 1% for early stage tumors and approximately 5% for late stage tumors.

### Purpose or Objective
To explore the ability of quantitative prostate T2-weighted (T2-w) and apparent diffusion coefficient maps (ADC) MRI using Haralick texture features: i) to differentiate prostate cancer (PC) from healthy tissues; ii) to correlate with Gleason score; iii) to predict biochemical recurrence after external beam radiotherapy (RT) for prostate cancer.

### Material and Methods
Tumor and prostate zones were segmented on co-registered T2-w and ADC on two pre-treatment 3.0T MRI from 83 patients with a median age 67 years (range 50-82 years) and a median pre-treatment PSA of 9.8 ng/ml (range 3.4-48.0 ng/ml). 9 (11%) tumors were localized in the transitional zone (TZ) and 74 (89%) in the peripheral zone (PZ). Tumors were clinically staged as follows: 13% of T1, 46% of T2 and 41% of T3. Gleason scores were as follows: 6 (27%), 7 (51%), 8 (20%) and 9 (2%). They were 2% of low-risk, 33% of intermediate-risk and 65% of high-risk tumors according to D’Amico risk group classification. Almost all patients received standard treatment consisting in IMRT (100%) with IGRT (94%) associated with hormonal therapy in 53% of the patients. After a median follow-up of 47 months (range 19-65 months), 11 patients had biochemical recurrence. A total of 114 grey-leveled features (first order, gradient-based and second order Haralick texture characteristics) and 4 geometrical features (maximal tumor diameter, maximal tumor perimeter, maximal tumor area and tumor volume) were extracted on normalized T2-w and ADC and were analyzed. Statistical analyses were performed using Wilcoxon signed-rank test, Spearman’s correlation coefficient, Harrell’s C-index, Kaplan-Meier curves and univariate Cox regression analysis.

### Results
i) 56 out of 57 T2-w and 46 out of 57 ADC grey-leveled features were significantly different between tumor and prostate tissues in the TZ and 25 out of 57 T2-w and 37 out of 57 ADC features in the T3 (p<0.05). ii) 5 T2-w features and 4 ADC features were significantly correlated with Gleason score, all were Haralick texture features. iii) T2-w features that significantly predicted (p<0.05) biochemical recurrence were: maximal tumor diameter/perimeter/area/volume, Kirsch gradient operator, normalized mean and standard deviation of signal intensity and 8 Haralick texture features (Difference Variance, Contrast, Inverse Difference Moment, Difference Entropy, Information Measure of Correlation, Sum Average, Sum Variance and Sum of Squares). Only normalized mean value on ADC was significantly predictive of biochemical recurrence.

### Conclusion
Quantitative analysis using Haralick texture characteristics on T2-w MRI are good features: i) to differentiate prostate cancer from healthy tissues, ii) for Gleason score assessment and iii) to predict biochemical recurrence after RT. Geometrical characteristics extracted from T2-w are also good predictors of biochemical recurrence after RT.

### Poster Viewing: 10: Physics: Functional Imaging II

**PV-0473**
Diagnostic and predictive values of quantitative analysis on T2-w and ADC map MRI in prostate cancer
K. Gnep1, A. Fargeas2, R.E. Gutiérrez-Carvajal3, F. Commandeur4, R. Mathieu2, J.D. Ospina3, G. Jimenez2, T. Rouhou1, O. Acosta2, R. De Crevoisier4
1Centre Eugène Marquis, Radiotherapy, Rennes, France
2Inserm U1099- University of Rennes 1, LTSI, Rennes, France
3Centre Hospitalo-Universitaire Pontchaillou, Urology, Rennes, France
4Centre Eugène Marquis, Radiology, Rennes, France

**Purpose or Objective:** To explore the ability of quantitative prostate T2-weighted (T2-w) and apparent diffusion coefficient maps (ADC) MRI using Haralick texture features: i) to differentiate prostate cancer (PC) from healthy tissues; ii) to be correlated with Gleason score; iii) to predict biochemical recurrence after external beam radiotherapy (RT) for prostate cancer.

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**PV-0474**
Comparison of DCE MRI and FMISO-PET kinetic parameters in head and neck cancer patients
U. Simonic1,2,3, S. Leibfritz1, S. Welz4, N. Schwenzer4, H. Schmidt5, D. Zips6, D. Thorwarth1
1University Hospital Tübingen, Section for Biomedical Physics - Department of Radiation Oncology, Tübingen, Germany
2Jozef Stefan Institute, Medical Physics program, Ljubljana, Slovenia
3University o Ljubljana, Faculty for Mathematics and Physics, Ljubljana, Slovenia
4University Hospital Tübingen, Department of Radiation Oncology, Tübingen, Germany
5University Hospital Tübingen, Department of Diagnostic and Interventional Radiology, Tübingen, Germany
6University Hospital Tübingen, Section for Biomedical Physics - Department of Radiation Oncology, Tübingen, Germany

**Purpose or Objective:** Tumour hypoxia is associated with poor response to radiotherapy. Comprehensive hypoxia assessment through [18F]-fluoromisonidazole (FMISO) PET imaging requires quantitative techniques, such as dynamic acquisition. However, dynamic FMISO PET protocols might be simplified by using DCE-MRI imaging in addition to static FMISO-PET. The aim of this work was to compare FMISO and DCE-MRI kinetic parameters by means of correlation analysis.

**Material and Methods:** This study was done on N=6 head and neck cancer patients, who were imaged dynamically with FMISO-PET and DCE-MRI on the same day. Images were registered and analyzed for kinetics on a voxel basis. FMISO-
PET images were analyzed with a two-tissue compartment three-rate constant model with an additional vasculature compartment. Consequently, the model had the following parameters: K1 - FMISO transport rate to the tissue, K2 - FMISO backflow parameter, k3 - rate of FMISO binding in the cells, and Vb - vasculature fraction in the tissue. DCE-MRI images were analyzed with the extended Tofts model with the following parameters: Ktrans - contrast agent transport rate to the tissue, ve - relative volume of the tissue, and vp - vasculature fraction in the tissue. Voxel-wise Pearson correlation coefficients were evaluated on pairs of parametric images for each patient over the tumour volume including lymph nodes and tumour bed, if present. FMISO kinetic parameters were modelled with multivariate linear models of DCE-MRI parameters. The relative likelihood of the models was evaluated using the Akaike information criterion.

Results: Correlations between FMISO and DCE-MRI kinetic parameters, median over all the patients, varied across the parameter pairs from -0.12 to 0.71, with the highest correlation coefficient of 0.71 for Vb-vp pair, while K1-Ktrans correlation was 0.46. Correlations between FMISO and DCE-MRI kinetic parameters varied also across the patients. Among various multivariate models for FMISO parameters, those with more DCE-MRI parameters were more likely. Table 1 shows the correlation matrix for FMISO and DCE-MRI kinetic parameters with the median over all the patients in the lower-left and minimum/maximum in the upper-right triangle.

Table 1: Correlation matrix for FMISO and DCE-MRI kinetic parameters.

<table>
<thead>
<tr>
<th></th>
<th>K1</th>
<th>K2</th>
<th>Ktrans</th>
<th>Ktransv</th>
<th>ve</th>
<th>vp</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>1</td>
<td>0.8</td>
<td>0.39</td>
<td>0.08</td>
<td>0.27</td>
<td>0.4</td>
</tr>
<tr>
<td>K2</td>
<td>0.92</td>
<td>0.04</td>
<td>0.08</td>
<td>0.51</td>
<td>0.59</td>
<td>0.33</td>
</tr>
<tr>
<td>Ktrans</td>
<td>0.02</td>
<td>0.01</td>
<td>0.58</td>
<td>0.51</td>
<td>0.33</td>
<td>0.68</td>
</tr>
<tr>
<td>Ktransv</td>
<td>0.02</td>
<td>0.04</td>
<td>0.01</td>
<td>0.51</td>
<td>0.33</td>
<td>0.68</td>
</tr>
<tr>
<td>ve</td>
<td>0.18</td>
<td>0.3</td>
<td>0.02</td>
<td>1</td>
<td>0.56</td>
<td>0.02</td>
</tr>
<tr>
<td>vp</td>
<td>0.46</td>
<td>0.39</td>
<td>0.15</td>
<td>0.15</td>
<td>1</td>
<td>0.06</td>
</tr>
<tr>
<td>Fmiso</td>
<td>0.09</td>
<td>0.06</td>
<td>0.04</td>
<td>0.12</td>
<td>0.42</td>
<td>1</td>
</tr>
<tr>
<td>Tofs</td>
<td>0.42</td>
<td>0.5</td>
<td>0.02</td>
<td>0.71</td>
<td>0.58</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Results: For comparison purposes, generated probability maps were thresholded with a value of 0.5. Thus, only voxels with values higher than 0.5 on the probability map were considered as relapse. The sensitivity and specificity of the proposed system were 0.80 (±0.19) and 0.87 (±0.09), respectively. For our data, standard Choline-to-NAA index (CNI) achieved a sensitivity of 0.62 (±0.25) and a specificity of 0.63 (±0.13) (an optimal CNI threshold was derived for all the patients). The receiver operating characteristic (ROC) curve also shows that the presented approach outperforms CNI (Fig 1.). In addition, the SVM-based results had lower variation across patients than CNI. An example of a probability map generated by the proposed approach is shown in Fig.2. Relapse areas predicted by the learning scheme are in high agreement with the manually contoured regions.