Comparison of physiological and descriptive parameters of intensity-time-curves derived from Gd-DTPA enhanced dynamic MRI for the assessment of prostate cancers in patients.

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Synopsis

Several studies showed that the diagnosis of prostate cancer is improved using dynamic Gd-DTPA enhanced MRI [1, 2, 3]. However, there is a large discordance about the optimal time and spatial resolution as well about the analysis of dynamic data. Parameters of the signal-intensity-time-curves can directly result from curve discussion as start of enhancement, time to peak, slope, and wash out or derive from more complex pharmacokinetic models considering physiological aspects (e.g.. tissue blood volume, vessel permeability and perfusion). The purpose was to compare the discrimination of prostate cancers from the non-affected gland using parameters of the physiological two-compartment model of Brix [4] and mathematical ones. Furthermore, data was correlated with micro vessel density determined in excised tumors.

Methods

Twenty-five patients (24 with histological proven carcinomas) were examined with multiplanar T2 and T1-weighted MRI (1.5T Magnetom Symphony, Siemens, Germany). Dynamic imaging was performed using a 0.1mmol/kg Gd-DTPA (Magnevist, Schering, Berlin, Germany) enhanced T1w-FLASH sequence with 25 measurements (TR/TE=125/3.11ms; slice thickness: 3mm; voxel size: 2.1x1.6x3.0mm; matrix: 128x160; time resolution: 13 seconds). Contrast agent was injected during 30 seconds starting after the 3rd dynamic measurement using a pump controlled injector. Regions of interest were defined in tumors and non-affected areas. Dynamic data were parameterized in amplitude and exchange-rate constant (k_{ep}) using an open pharmacokinetic two-compartment model. Additionally, the shape of intensity-time curves, relative slope determined between the last baseline point and the following time point after 26, 39, 52 and 65 seconds, areas under the curve (AUC) and time to start of signal-intensity increase (t_{lag}) were determined. For correlation with dynamic MRI data, vessel density (VD) of excised prostates was quantified in tumor areas using a CD34 stain.

Results

In 14 of 24 tumors intensity time curves showed an initial increase and a plateau or a continuous increase (shape 1). An initial increase with early decrease (shape 2) was only observed in 10 cases. In normal non-affected prostate tissue shape 2 was only found in 3 ROI, whereas shape 1 was predominant. All parameters describing the early signal intensity increase, which were slope26 ($p=0.0005$), slope39 ($p=0.0002$), slope52 ($p<0.0001$) and slope65 ($p<0.0001$), were significantly higher in tumors than in the normal peripheral gland. Of all parameters determined the slope52 showed superior sensitivity (71%) and specificity (86%) for discriminating tumors by 50% higher values ($p=0.0005$). Although differences between tumor and peripheral gland were also significantly found for the parameters amplitude ($p=0.0008$) and k_{ep} ($p=0.02$) of the Two-compartment model, discrimination was less pronounced. Higher values in tumors were also found for the AUC (<0.01). In contrast to results of other groups (2), t_{lag} was not capable to discriminate carcinoma in this study. VD was higher in tumors than in the non-tumor tissue ($p=0.05$). However, none of the dynamic parameters in carcinomas correlated with VD.

Discussion

Although pharmacokinetic models in dynamic MRI suggest a patho-physiological basis for tumor characterization, in this study discrimination of prostate cancers was more reliably using descriptive parameters. Of all parameters determined, slope52, which describes the early signal enhancement after contrast agent injection, showed best results.

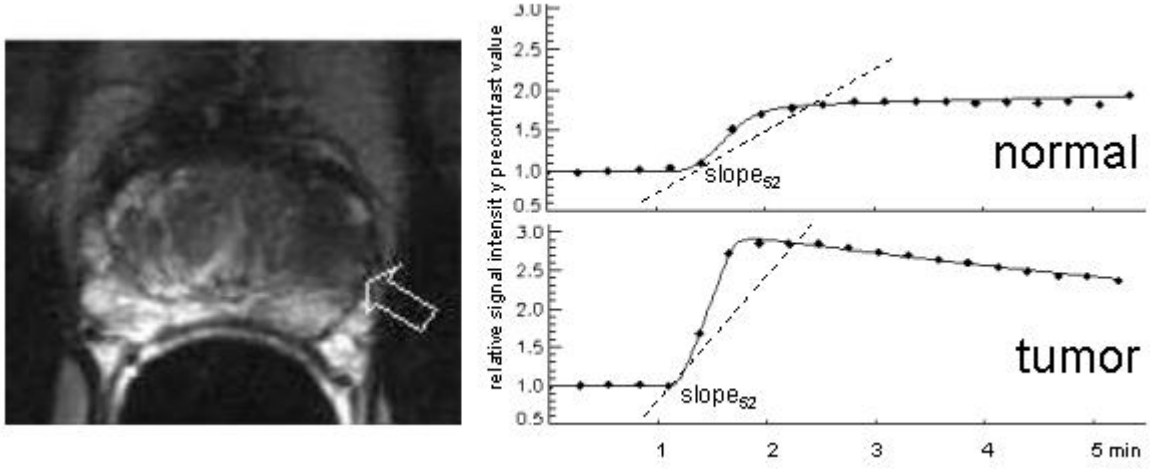

Figure 1: **T2w images (left) of a prostate carcinoma localised in the peripheral and central gland. The carcinoma (arrow) is detected by a signal intensity decrease. The typical signal intensity-time cuve (C) shows a sharp initial increase in signal intensity.**

References

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