Applications of Perfusion MRI in the Body

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Dynamic contrast-enhanced MRI (DCE-MRI) is a noninvasive imaging technique based on dynamic acquisition during the transit of a small-molecular-weight contrast agent, particularly Gadolinium-derivates. Contrast enhancement and washout are related to tumor physiology and vasculature. Compared to DCE-CT, acquisition time is not limited by radiation and temporal resolution is usually higher, so that tumor blood flow, vascular permeability and the volume of extracellular space can be assessed more precisely [1, 2]. Unlike in iodinated agents, the relationship between change in MR signal intensity and contrast agent concentration is not linear at high concentrations [3], so that examinations with only low doses of contrast agents are warranted. In contrast to DCE-Ultrasound, DCE-MRI is user independent and allows to depict the whole organ/ tumor of interest.

Organ and tumor perfusion and permeability can be assessed from DCE-data using semiquantitative or quantitative analysis with different kinetic models. A semiquantitative (model-free) parameter is the initial area under the contrast agent concentration-time curve (IAUC) quantitating the total gadolinium uptake over the first 60 to 90 s after contrast arrival into the tumor, but it represents a composite of perfusion and permeability [2]. The quantitative Tofts-model produces the parameter K^{trans} reflecting tumor blood flow and permeability dependent on tumor vascularity. Decreasing tumor blood flow and permeability after tyrosine-kinase target therapy have the potential to serve as predictive pharmacodynamic biomarker of response in advanced tumors [4].

Evaluation of targeted antivascular therapy in clinical routine is currently based only on morphological assessment, such as the RECIST criteria, but changes in tumor size may lag behind functional changes. In DCE-MRI, tumor blood flow and microvessel permeability can be asseesed, which may precede tumor shrinkage. Generally, a decrease in Ktrans and/or IAUGC has been described by studies investigating DCE-MRI parameters after administration of anti-VEGFR agents [5, 6].

One of the major factors affecting reproducibility and reliability of functional imaging is the definition of region of interests (ROI), from which the quantitative data is derived. Up to date there is no recommendation for ROI placement into the tumor, although it is recommended to use the viable part of tumor with necrosis <50%. Other major confounding factors are the selection of the arterial input function [7] and the administered contrast agent [8].

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