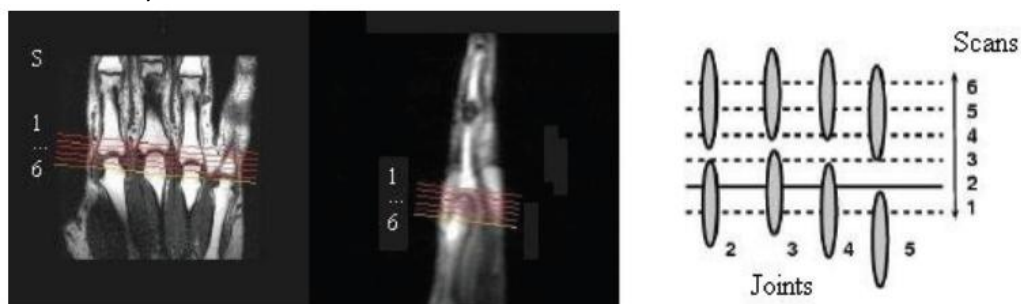


## DCE-MRI Data

To obtain dynamic contrast-enhance MRI (DCE-MRI) series, sequences of images are acquired from the joints over time, during which a contrast agent pre-injected into a patient enhances disease affected tissues. Measurement of this enhancement, which is specific for voxels representing particular tissue types, allows assessment of the patient's condition.

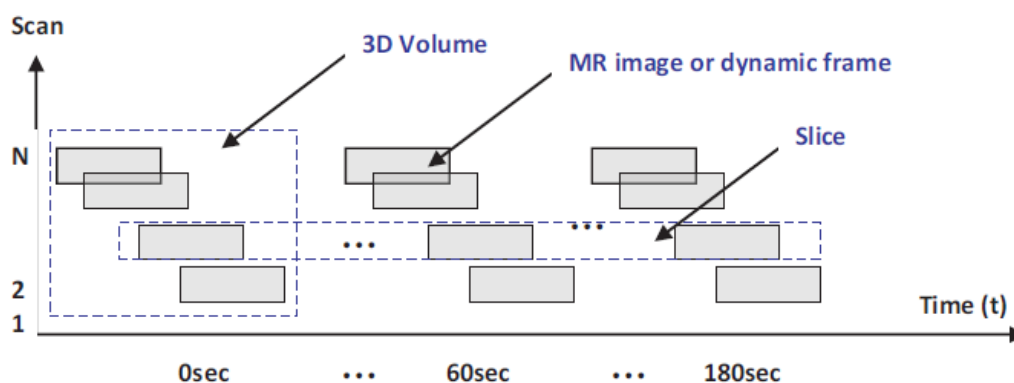
Schematically a DCE-MRI dataset is shown below:



**Figure:** Left: Positioning of slices before the data acquisition. At these static positions, further dynamic MRI will be acquired. Right: A coronal plan of the phalanges. Six scans of four phalanges of the joints. A schematic representation of the scans and MCP joints. [published by O. Kubassova, 2007]

Below is another schematic representation of DCE-MRI data, where 2D images are grouped into slices, or slices and volumes.

**NOTE:** A slice is a sequence of 2D images acquired from the same physical location at different time instances. A single 2D image in the DCE-MRI study is called a dynamic frame.



**Figure:** A schematic structure of 4D DCE-MRI experiment: 3D volumes of images are composed of S scans and acquired over time T. The acquisition parameters are specific for a given MRI scanner and are chosen by a radiologist to ensure maximum exposure of the disease affected tissues.

After performing a dynamic study, a large number of images has to be evaluated qualitatively and quantitatively. Evaluation of a series of images obtained with DCE-MRI can be performed in different ways:

1. A simple, but subjective, qualitative method is the '**naïve review method**', in which an observer examines the contrast enhancement sequentially on all images of the dynamic

sequence. With this method detection of small areas of enhancement or areas with discrete enhancement (especially in the wrist studies) can be difficult.

2. Early qualitative analysis methods were based on **image subtraction**, in which the first image (i.e. before contrast injection) is subtracted from all subsequent images of the dynamic study. The subtraction images are then viewed one by one. With such method it is possible to detect the most enhancing tissues (for biopsy or injections). Estimation of heuristics such as the magnitude of enhancement and time of onset of enhancement or recognition of the late enhancing tissues such as fat on the early subtracted images is difficult.
3. Quantitative analysis of DCE-MRI data can be performed using various **pharmacokinetic methods**, which provide a framework that can be used to link the physics of MRI signal acquisition and the underlying patho-physiology that governs contrast agent kinetics. Comparative analysis of these methods can be found in [1,2]. In clinical practices, it is impossible to assess the accuracy with which pharmacokinetic variables reflect the true underlying changes in concentration of the contrast agent [3]. The accuracy of the estimates will depend on the pharmacokinetic model used and the signal to noise ratio in any individual case. This is a particular problem with applications where noise is the dominant or the only cause of variation of contrast agent concentration [3].
4. Further contrast enhancement can be quantified in terms of **heuristic methods**, which estimate parameters such as maximum enhancement (*ME*), initial rate of enhancement (*IRE*), and time of onset of enhancement (*Tonset*). These heuristic parameters have been seen to highly correlate with pharmacokinetic measurements of inflammation [4,5,6]

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