Development and clinical applications of the time intensity curve shape analysis in dynamic contrast enhanced MRI: a pixel-by-pixel approach

Lavini, C.

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APPENDIX 1

Software DYNAMO

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DCE-MRI analysis package comprising pixel-by-pixel classification of Time Intensity Curves shapes, permeability maps and Gd concentration calculation.

C. Lavini, M. Maas.

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Dynamic Contrast Enhanced MRI (DCE-MRI) is used routinely in many clinical settings. For the radiologist it is important for the DCE-MRI evaluation to be able to easily spot areas of abnormal enhancement accompanied by anomalous Time Intensity Curves (TICs), i.e. areas with a quick contrast uptake and fast wash-out. For this purpose we developed an algorithm that rapidly classifies curve shapes on a pixel-by-pixel basis [1]. We assign to each pixel/voxel a unique shape type, numbered from 1 to 7, as in the figure on the left. The result of the classification is rendered in colour-coded shape maps for easy reading.

In this GUI we offer the above tool implemented in a user-friendly environment, together with a number of other research-oriented tools, such as the calculation of Gd concentrations, calculation of the Arterial Input Function, calculation of tissue permeability according to the popular generalized Toft’s model [2], and other tools for statistical analysis. A combined analysis of the three methods is also possible.

In this way the pixel-by-pixel DCE-MRI TIC shape analysis can be applied in a clinical setting, and compared to the result of the quantitative analysis, when applicable. In this exhibition we also demonstrate the application in a clinical context in tumours and synovitis.

**Qualitative analysis**

Together with the TIC shape analysis as described in ref [1], qualitative parameters maps are offered such as Maximum Enhancement (ME), Time to Peak, Initial slope of increase, or Initial area under the curve (IAUC).

It is possible to calculate image statistics on either the whole image, or on selected ROIs.
Quantitative analysis.

This tool allows calculation of **T1 maps**, if the necessary MR images exist (i.e. a series of IR images, a Look-Locker series, or a series of GRE with variable flip angle). Another tool (in a separate window, not shown here) allows to select arteries, manually or automatically, and calculate the **arterial input function**. An algorithm allows calculating reliable AIFs also with poor temporal resolution of the original data [3].

**Tissue permeability** can then be calculated according to the generalized Tofts model (generating $K^{\text{trans}}$, $v_e$, $v_i$) as in [2] making use of different functional forms for the AIF.

The program also offers the possibility of calculating statistics and histograms on the calculated maps, either for a single patient or in a multi-patient study setting.

All maps can be saved as DICOM or TIFF images, and results of statistics can be exported in excel.

This software is implemented in Matlab, and is called **DYNAMO**

References:


Contact: clavini@amc.uva.nl (physicist) or m.maas@amc.uva.nl (radiologist)