**BASICS: Perfusion methods of deconvolution (MRI DSC & CT)**

1. **DYNAMIC SUSCEPTIBILITY CONTRAST (DSC) IN A NUTSHELL**

- Dynamic susceptibility contrast (DSC) is a perfusion imaging technique performed after the administration of intravenous contrast agent to non-invasively access tissue and vascular perfusion characteristics.
- This perfusion technique is widely used for quantification of cerebral perfusion.
- Accurate perfusion measurement provides important diagnostic information on pathological conditions.
- CT and MR raw data are post-processed to obtain perfusion maps with different parameters, such as BV (blood volume), BF (blood flow), MTT (mean transit time), TTP (time to peak) and Tmax (time to maximum of the tissue residue function).
- The standard perfusion models use deconvolution methods that can be classified into two main families:
  - Non Adaptive approaches (sSVD and cSVD)
  - Semi and fully adaptive approaches (oSVD and Bayesian)
- Today, Olea Medical® is the only manufacturer to give access to all 4 different methods:
  - **sSVD**: standard truncated SVD (sSVD), as originally proposed by Ostergaard et al.
  - **cSVD**: block-circulant SVD (cSVD), extension of sSVD, which has been shown to be less sensitive to tracer delays.  
  - **oSVD**: Oscillation-index cSVD (oSVD), an iterative method repeating the cSVD deconvolution process until the oscillation in the residue function is below a threshold defined by the oscillation index (OI).  
  - **Bayesian method**, a rigorous probabilistic estimation of hemodynamic parameters.
2. MAIN DIFFERENCE BETWEEN DECONVOLUTION METHODS AT A GLANCE

1. Non adaptive approaches (sSVD and cSVD)

- sSVD is considered as **delay sensitive**
- cSVD is considered as **delay insensitive**

Both methods:
- depend on a threshold determining the number of small singular values to be truncated
- use average threshold values

2. Semi and fully adaptive approaches (oSVD and Bayesian)

- oSVD is considered as **delay-insensitive & semi-adaptive** since the number of small singular values to be truncated is determined for each voxel by minimizing a smoothness criterion on the residue function, leading to:
  - a more robust and more accurate estimate
  - a better predictive potential (among SVD-based deconvolution methods)

- **Bayesian method** outperforms deconvolution methods (standard, block-circulant or oscillating Singular Value Deconvolution) from a quantitative point of view. The Bayesian method is more accurate and more robust against noise and truncation than oSVD.
3. PRACTICAL CASES FOR PERFUSION (DSC) POST-PROCESSING

CTP (stroke)

**MTT MAPS (acute MCA M1 occlusion)**

Bilateral wide areas with falsely increased MTT are identified on MTT maps computed from cSVD and oSVD deconvolution methods.

Bayesian processing solves this problem by delimiting the abnormal MTT increase within the right MCA territory (refer to blue pointers).

**CBF MAPS (acute MCA M1 occlusion)**

Cortical CBF seems almost totally preserved in right MCA territory with cSVD or oSVD deconvolution methods.

Bayesian processing corrects this error by highlighting the decrease in cortical CBF in the whole right MCA territory (refer to blue pointers).

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**MR-PWI (stroke)**

**MTT MAPS (acute MCA M1 occlusion)**

The ischemic area is not well identified on MTT maps computed from cSVD and oSVD deconvolution methods.

Bayesian processing solves this problem by perfectly delimiting the hypoperfusion within the whole right MCA territory (refer to blue pointers).

**CBF MAPS (acute MCA M1 occlusion)**

Cortical CBF seems totally preserved in right MCA territory with cSVD or oSVD deconvolution methods.

Bayesian processing allows to emphasize the clear decrease in cortical CBF in the whole right MCA territory (refer to blue pointers).
4. THE IMPORTANCE OF LEAKAGE CORRECTION FOR ACCURATE PARAMETERS

- Leakage of contrast material in neovascular lesions leads to underestimation of the relevance of rCBV.

- Any model attempting to accurately track perfusion changes must account for the leakage correction in order to:
  - Better distinguish low, intermediate and high grade.
  - Differentiate treatment effects (radiation necrosis) from tumor recurrence.
  - Avoid the loss of rCBV correlation with grade observed when leakage correction is not applied.

- Olea Sphere™ offers leakage correction features, including k2 map, resulting from permeability qualitative maps.

Before leakage correction:

Suspicion of a high grade progressing cerebral tumor as originally suggested by the abundant vascularization on the CBV map (circular green area).

Erroneous diagnostic overestimation of the cerebral tumor degree can lead to an erroneous therapy (i.e. surgical and/or medical).

After leakage correction:

The CBV map shows a poorly vascularized tumor (blue area), typically characteristic for low grade glioma.

REFERENCES


9. ECR, 2013, Mar 7 – 11, Vienna, Austria.
