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Automatic detection of patient-specific perfusion abnormalities in Arterial Spin Labeling

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► **To cite this version:**

Camille Maumet. Automatic detection of patient-specific perfusion abnormalities in Arterial Spin Labeling. EU COST Arterial Spin Labeling in Dementia (AID) meeting, Oct 2012, Amsterdam, Netherlands. 2012. hal-04091254

HAL Id: hal-04091254

<https://inria.hal.science/hal-04091254v1>

Submitted on 7 May 2023

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Automatic detection of patient-specific perfusion abnormalities in Arterial Spin Labeling

COST AID meeting

Camille Maumet

October 15th, 2012

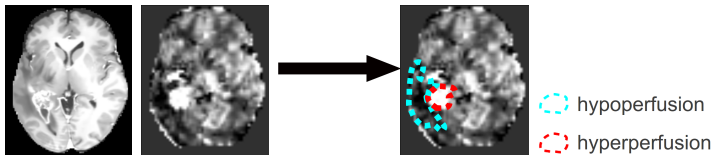


- 1 Context
- 2 Method
- 3 Results

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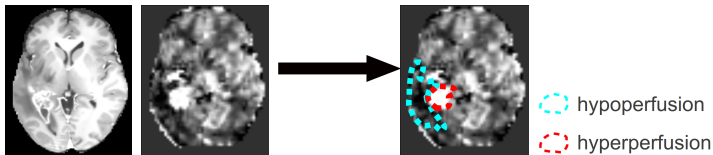
Objective

Quantitative *identification of voxelwise patient-specific perfusion abnormalities.*



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Quantitative *identification of voxelwise patient-specific perfusion abnormalities.*

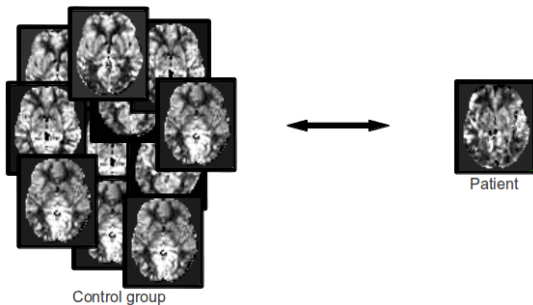


Challenges:

- Low signal-to-noise ratio of the Q2TIPS PASL sequence.
- Presence of artefacts.

- 1 Context
- 2 Method
 - Statistical analysis
 - Validation
- 3 Results

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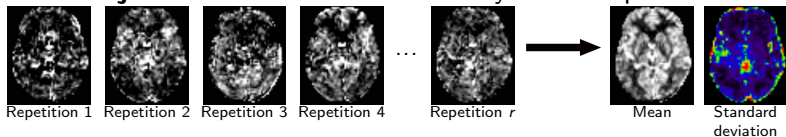
Method

Originality of our approach:

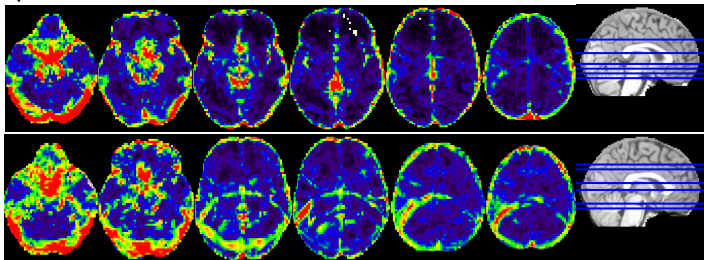
- *Explicit modelling of both **intra-subject** and **inter-subject** variances.*
- ***No pre-smoothing** of the data: a *contrario* approach.*

Intra-subject variance

Intra-subject variance models variability across repetitions

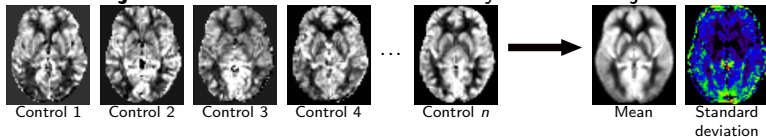


Examples

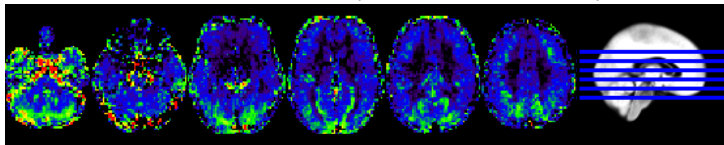


Inter-subject variance

Inter-subject variance models variability across subjects



Inter-subject standard deviation (35 healthy subjects)



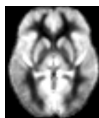
Detection of perfusion abnormalities

Model of normal perfusion:

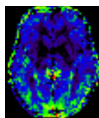


Patient map

$\sim \mathcal{N}(\mu, \Sigma)$



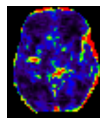
Mean across subjects



Inter-subject variance

Σ

+

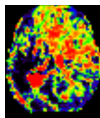


Intra-subject variance

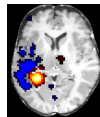
Σ

)

Detection of hypoperfusions and hyperperfusions:



Voxel-based probabilities



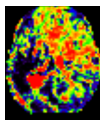
Detections

■ hypoperfusion
■ hyperperfusion

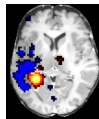
Known as a mixed-effect general linear model.

Detection of perfusion abnormalities

Mixed-effect General Linear Model:



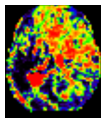
Voxel-based probabilities



Detections

■ hypoperfusion
■ hyperperfusion

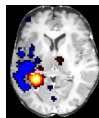
Mixed-effect *a contrario* approach:



Voxel-based probabilities



Region-based probabilities



Detections

■ hypoperfusion
■ hyperperfusion

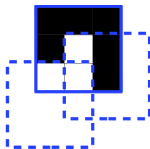
From voxel-based to region-based probabilities:



1. Voxel-based probability



2. Thresholding



3. Rare event count per region

1	1	1
3	3	2
3	3	2

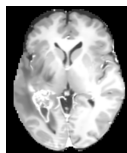


4. Region-based probability

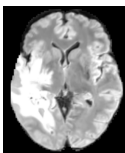
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Ground Truth estimation

Step 1 – Segmentation of the tumor:



T1 Gadolinium



T2 FLAIR

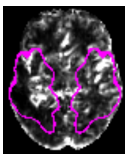


Tumor and
edema
segmentation

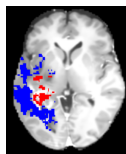
Step 2 – Combination with T2 perfusion information:



Tumor segment.



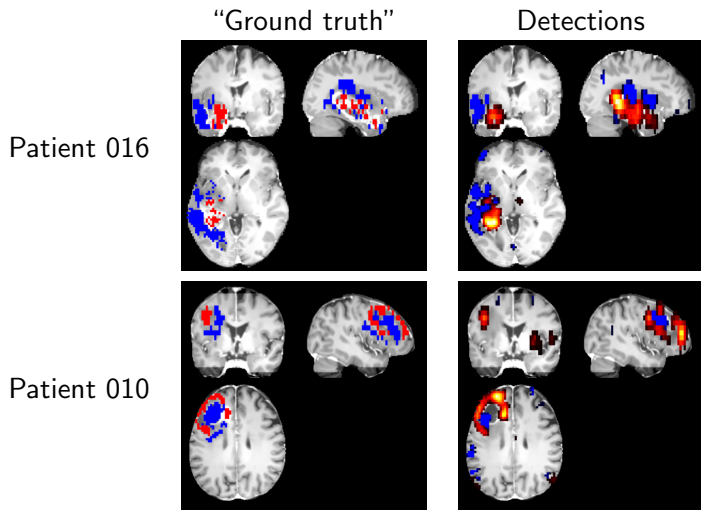
DSC CBF

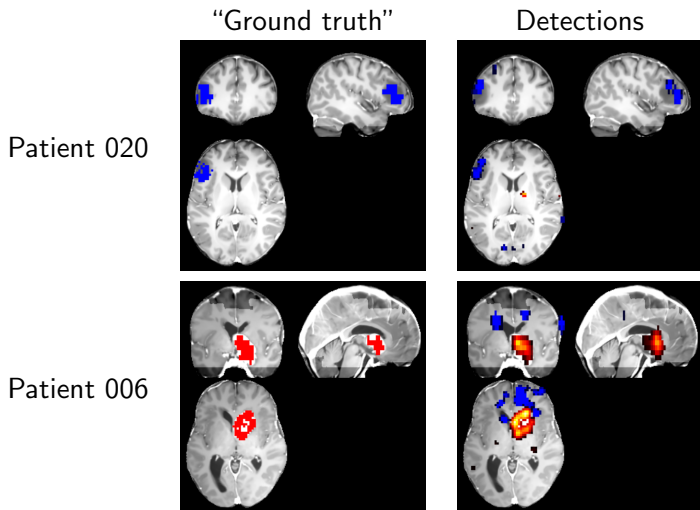


"Ground truth"

Step 3 – Visual assesment and manual corrections by a clinician

- 1 Context
- 2 Method
- 3 Results**



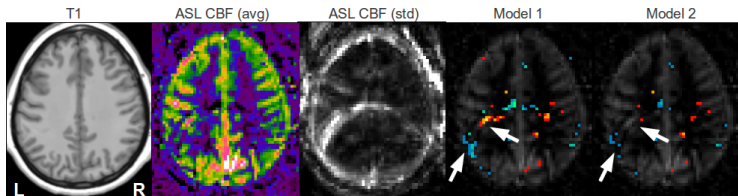


Quantitative results on a dataset including 22 patients and 35 controls:

	Acontrario Mixed-effects
Specificity (controls)	0.99
Specificity (patients)	0.93
Sensitivity (hyper)	0.82

Results: Importance of intra-subject variance

Effect of intra-subject variance on the detections:

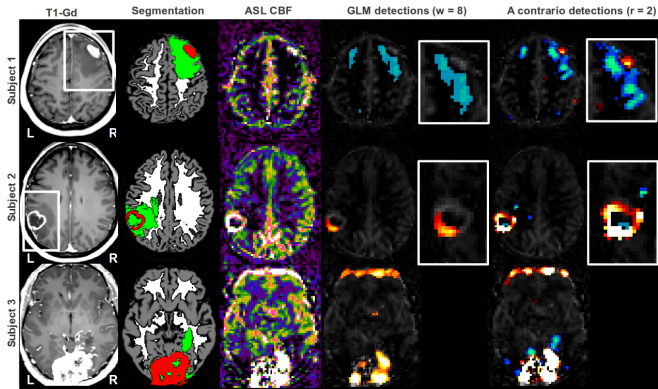


Quantitative results (22 patients, 35 controls):

	A contrario Mixed-effects	A contrario Random-effects
Specificity (controls)	0.99	0.92
Specificity (patients)	0.93	0.56
Sensitivity (hyper)	0.82	0.86

Results: advantage of the a contrario approach

A contrario approach and Mixed-effect General linear model detections:



Conclusions:

- Importance of intra-subject variance in the detection of patient-specific perfusion abnormalities.
- Good sensitivity and specificity of the proposed approach.
- Region-based *a contrario* probabilities outperform the standard voxel-based probabilities.

More details on the *a contrario* approach: C. Maumet, P. Maurel, J.-C. Ferré, and C. Barillot, “A comprehensive framework for the detection of individual brain perfusion abnormalities using arterial spin labeling” MICCAI 2012, pp. 542–549.

Q & A