Mapping of cerebral vascular territories using whole brain perfusion CT imaging: A new method

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Introduction

• Collateral blood supply is believed to be a key determinant of tissue survival in acute stroke
  – May add to perfusion metrics in determining whether tissue is at risk or not [1]

• Collateral characterization remains elusive in acute ischemic stroke

• Digital Subtraction Angiography

• Vessel Selective arterial spin labelling

Introduction

• We have previously described a method to label the major vascular territories on MRI using the dynamic susceptibility perfusion raw data also used to generate the usual perfusion maps [1]

• The method relies on small differences in arrival of tracer agent to each voxel to infer the direction of flow – needs continuous, full brain high resolution coverage

• New multi detector CT, allows for use of this technique on CT Perfusion data

[1] Christensen et al. JMRI 2008
Hypothesis

• CTP based Vascular Territory Maps of acute stroke patients would display redistribution of the flow territories concordant with CT angiography (CTA)

• We qualitatively compared the territory maps with the CTA determined site of occlusion
Methods

• Patients with acute stroke imaged <6 h from onset
• Data acquired on a Toshiba Aquilion One 320 slice system, standard perfusion protocol
• Vascular territory maps
  – Regions of interest (ROI) were placed in the MCA, PCA and ACA
  – Algorithm tracks the inflow pattern from the ROIs
  – Territories are then labelled with colors

• Vascular territory maps were then compared to CTA by experienced neurologist and classified plausible yes/no
Results

- We were able to generate interpretable images in 14 of 19 cases
  - 5 excluded due to head motion and/or poor signal enhancement during the bolus passage
Results

• Fourteen patients were included with the following CTA findings
  – 2 M1 occlusions
  – 11 no visible occlusion
    • 10 had perfusion abnormalities (TTP) corresponding to distal branches (ACA, MCA) below the resolution of the CTA
  – 1 ICA occlusion
Results – M1 occlusion #1
Results – M1 occlusion #1
Results – M1 occlusion #2
Results – M1 occlusion #2
Results – No occlusion, no PWI abnormality
Patient #3 Acute Time point – MCA branch occlusion
Patient #3 24 H – post recanalization
Results

• Distributions of vascular territories in the non affected hemisphere were in good agreement with textbook distribution patterns

• In the affected hemisphere, the vascular territory of the occluded vessel was either diminished or absent and the tissue instead supplied by adjacent territories

• In 2/14 cases the estimated collateral territory appeared inconsistent with physiological expectation
  – ACA occlusions pose problems
Discussion

• Initial results are promising
• Vascular territory imaging using CT perfusion data would open a window on the importance of extent and origin of collateral supply in acute stroke by quantifying collateral supply
• This technique is complementary to standard perfusion maps
• No need for additional hardware or higher radiation doses
Future directions

• Validation against territorial ASL
• Methodological enhancements
  – Automation of ROI seeding
  – Extra-cranial ROIs