SYMPTOMATIC HEMORRHAGIC TRANSFORMATION and MALIGNANT EDEMA after acute ischemic stroke: PREDICTION with VOLUMETRIC CT PERFUSION

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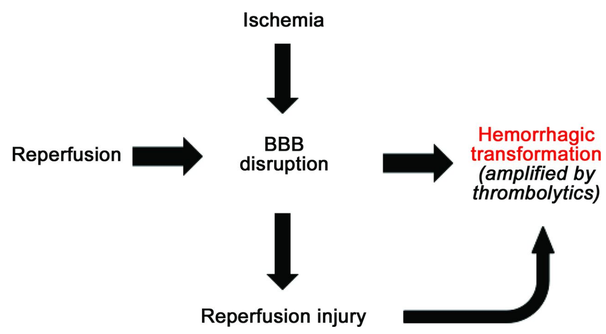
Background and purpose

- Symptomatic hemorrhagic transformation (SHT) and malignant edema (ME) are feared complications of acute ischemic stroke (AIS) and they can be exacerbated by the revascularization treatments of acute phase [1].
- CT perfusion (CTP), given informations about the extension of ischemic core, the impairment of blood-brain barrier permeability and the status of collateral circulation, may help to identify patients at high risk of developing such complications [2-3].
- Our study aimed to assess the diagnostic accuracy of a CTP-derived multiparametric score in predicting SHT and ME in a cohort of AIS patients.

Figure 1:
Schematic representation of BBB changes in acute ischemic stroke [1]



Methods

- *Patients:*
  Consecutive AIS patients involving the middle cerebral artery territory admitted in the Stroke Unit of Careggi University Hospital evaluated by volumetric CTP before possible thrombolytic treatment.
- *Imaging Protocol:*
  Whole-brain CTP, 96 mm coverage. CTP software (Siemens) to calculate core volume (cV), penumbra/core mismatch ratio (MR) and cerebral blood flow in the ischemic penumbra (pCBF); maps of surface permeability in the ischemic core (cPS) obtained with the Patlak model.
- *Outcome:*
  SHT and ME defined according to ECASS II criteria on 24h CT.
- *Statistical analysis:*
  ROC curves analyses to identify the thresholds of CTP-derived measurements, corresponding to the best pair of sensitivity and specificity able to predict SHT or ME. Volumetric CTP Stroke Score (VSS): defined by assigning 1 point when the CTP parameter is above the thresholds, 0 otherwise.

Results

- 28 AIS patients, mean age 69.3±13.4.
- Intra-arterial treatment (IAT) in 22 pt (TICI 2b/3 in 16 pt)

- 3 pt developed SHT: 1 PH1 (no treatment), 2 PH2 (1 IAT with TICI 2a, 1 no IAT).
- 3 underwent ME: 1 no recanalization, 2 no IAT

- The CTP-derived thresholds (and their sensitivity/specificity respectively) in predicting SHT or ME were showed in figure 2.
- A VSS>2 had a sensitivity of 83.3% and a sensibility of 86.4% in predicting both SHT and ME. With VSS=4, the predictive value for SHT showed 100% of sensitivity and specificity (Figures 3-6)

Figure 2: CTP values predicting SHT/ME

- cV>20.6cm3 (100/72.7%)
- cPS>2.54ml/100g/min (66.6/54.5%)
- MR<1.7 (83.3/90.9%)
- pCBF<28.3ml/100g/min (83.3/45.4%)

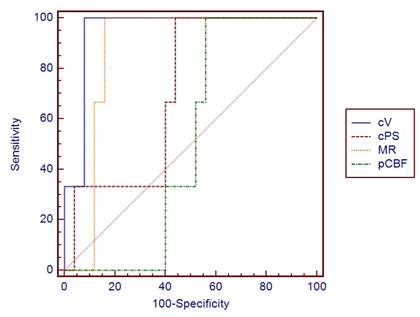


Figure 3: VSS predicting SHT/ME

- VSS>2 (83,3/86,4%)

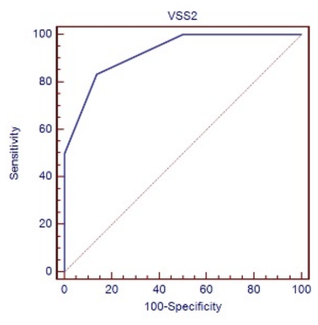


Figure 4: VSS predicting SHT

- VSS=4 (100/100%)

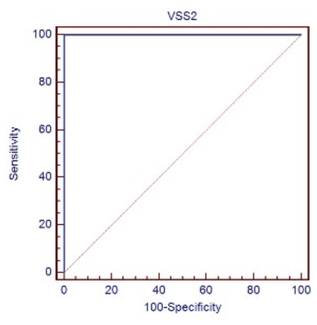


Figure 5: Example of CTP prediction of ME

- M, 59 yo
- Left M1 occlus
- IAT

- cV 25
- MR 5
- pCBF 19.7
- cPS 2,9,
- VSS 3

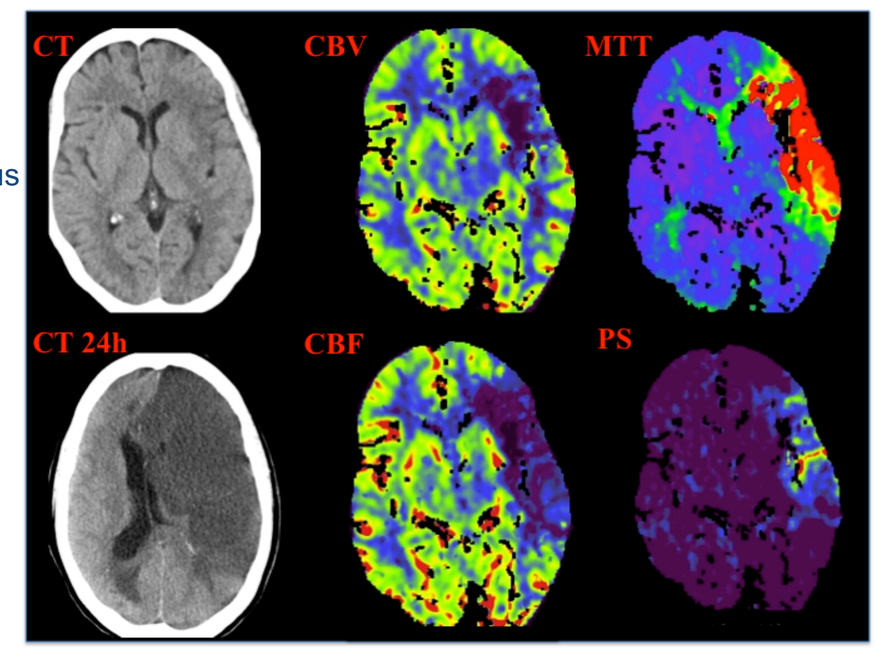
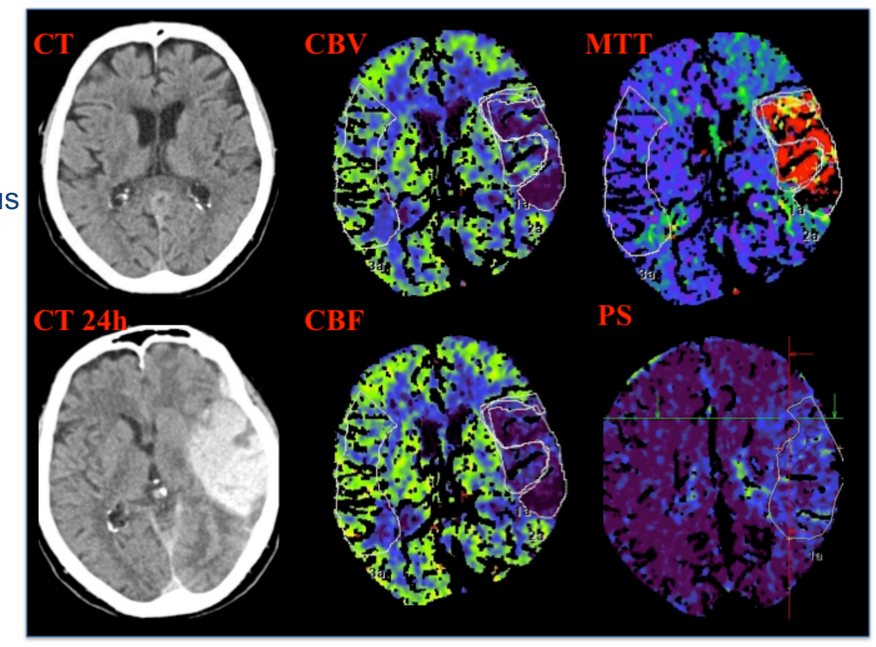


Figure 6: Example of CTP prediction of SHT

- F, 86 yo
- Left M1 occlus
- rtPA

- cV 32
- MR<1
- pCBF 20
- cPS 2,8
- VSS 4



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Conclusions

- Our preliminary data suggest that volumetric CTP-based measurement of various parameters may help to predict the risk of SHT and ME after AIS.
- Their combination in a multiparametric score showed high sensitivity and specificity in hemorrhagic prediction
- This promising pre-treatment score will hopefully be confirmed in our ongoing prospective study:

Reperfusion Injury in Stroke (RISK) Study