Mean transit time

Mean transit time is the average period of time that blood, or an element of blood such as a single red blood cell, spends within the blood vessels in a particular part of the brain. MTT is measured in seconds and is typically on the order of 6 seconds in normal brain tissue.

Perfusion computed tomography (CT) is a technique that allows rapid qualitative and quantitative evaluation of cerebral perfusion by generating maps of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT). The technique is based on the central volume principle (CBF = CBV/MTT) and requires the use of commercially available software employing complex deconvolution algorithms to produce the perfusion maps.

A meta-analysis of quantitative parameters showed that mean transit time represented the most valuable predictor for perfusion computed tomography for delayed cerebral ischemia diagnosis after aneurysmal subarachnoid hemorrhage when the calculation of the mean value was uniform (MD 0.30 s, 95% CI: 0.10 to 0.49 s, P = 0.003). Semi-quantitative parameters using relative values or index scores were also widely used to minimize undue variations derived from patients, operators, machines, and software. Studies also demonstrated that these relative parameters had better predictive accuracy than corresponding absolute parameters. Perfusion thresholds in each study were incomparable, and the results warranted further validation. The best threshold for the prediction was 0.9 using the relative cerebral blood flow parameter (sensitivity 97% and specificity 89%). They concluded that Perfusion computed tomography in the early phase is a promising tool for predicting delayed cerebral ischemia after aneurysmal subarachnoid hemorrhage. However, the parameters require standardization. Future studies with prospective, multi-centered design, and large sample size are needed to validate the thresholds and optimize the parameters [1)].

Normal values of MTT in the brain are:

gray matter: 4s

white matter: 4.8s

When the cerebral perfusion pressure (CPP) drops beyond the threshold of the brain auto-regulation, the compensatory cerebral vasodilatation, aiming to keep this pressure, becomes overwhelmed (see Monro-Kellie theory), and then the CBF starts to decrease in correlation with the CPP reduction. As a result, MTT will be prolonged. In the beginning, with a mildly reduced CBF, the red blood cells having a long contact time with the oxygen-permeable capillaries will allow an increased oxygen extracted fraction, and this may be sufficient to maintain the cerebral oxygen metabolism (“benign oligemia”) . However, after a certain point, this will not be sufficient and the brain cells will start to suffer (ischaemia).

We cannot expect favorable outcome for WFNS grade V patients with aMTT over 6.385 sec or more

than 2 among 8 areas with MTT >7.0 sec [2].

1)
Han H, Chen Y, Li R, Lin F, Lu J, Chen X, Wang S. The value of early CT perfusion parameters for predicting delayed cerebral ischemia after aneurysmal subarachnoid hemorrhage: a systematic review and meta-analysis. Neurosurg Rev. 2022 Apr 4. doi: 10.1007/s10143-022-01779-3. Epub ahead of print. PMID: 35377027.
2)
Sasahara A, Suzuki K, Takahashi Y, Koseki H, Hirota K, Ohbuchi H, Kasuya H. Prognostic assessment of aneurysmal subarachnoid hemorrhage patients with WFNS Grade V by CT perfusion on arrival. World Neurosurg. 2016 May 4. pii: S1878-8750(16)30226-1. doi: 10.1016/j.wneu.2016.04.097. [Epub ahead of print] PubMed PMID: 27155385.