Abstract

The brain being the central monitoring and controlling unit of the body, cerebral stroke is a lethal precursor of many disabilities in other organ(s), and hence the third leading cause of death across the globe. Brain stroke happens from reduced blood supply due to either blockage (ischemic) or rupture (hemorrhagic) in blood vessels. Noninvasive neuroimaging like magnetic resonance imaging (MRI) and computed tomography (CT) diagnose stroke – MRI is early in detection, while CT is relatively affordable and available. Manual quantification by traditional ABC/2 method suffers from observer variabilities and computer-aided severity diagnosis is desperately wanted. Current thesis proposes three types of algorithms – supervised (3D deep learning U-Net), semi-supervised (Autoencoder plus Chan-Vese model or snake-deformable model), and unsupervised (Gaussian mixture model or multiple abstract splitting plus seeded region growing) for delineation of stroke lesion from non-contrast CT (NCCT) as well as multi-sequence MRI data. Estimated lesion volume outperformed standard ABC/2 method (compared to manual ROI) in most cases, with unsupervised and semi-supervised (methods) being the consistent top performers (DSI 0.72±0.15 and 0.69±0.17 respectively). Beside stroke volume, herniation or brain midline shift (MLS) due to stroke is another crucial clinical marker. Current thesis work developed novel automated analytical tools for detecting ideal and deformed midline (iML, dML) by hemispheric segmentation, then quantifying MLS in 2D image-slices as well as 3D image-volumes, and finally correlating MLS with lesion volume and distances from iML/dML for stroke severity analysis. Extensive multi-variate correlation analysis between different indices of MLS (pixel-shifts, deformed-volumes) and hematoma (volumes, intensity, and distances from iML/dML) revealed that severity scoring by expert Radiologist (out of 0-5) is best correlated with (a) the combination of (hematoma-volume, volumetric MLS and minimum distance of hematoma from iML) with R^2 = 0.98 for epidural hematoma cases; and (b) with the combination of (hematoma-volume, pixel-wise MLS, and minimum distance of hematoma boundary from the dML) with R^2 = 0.70 for intra-parenchymal hematoma cases. These hold tremendous potential in quick and automated decision support for clinical prognosis and treatment planning of stroke.