Permeability of blood brain barrier during cerebral ischemia

Abstract

Cerebral ischemia remains a leading cause of long-term disability and mortality worldwide, with blood-brain barrier (BBB) dysfunction playing a crucial role in its pathophysiology. This dissertation investigates the mechanisms of BBB permeability changes during ischemic stroke through both clinical and experimental approaches, providing new insights into stroke progression and potential therapeutic interventions. The clinical study involved MRI-based analysis of BBB disruption in ischemic stroke patients during the subacute phase (7–12 days post-stroke). By utilizing advanced imaging techniques, we assessed the localization and extent of BBB impairment in relation to ischemic lesion subregions. The findings indicate a strong correlation between lesion volume and BBB leakage, with significant gadolinium extravasation observed in FLAIR positive regions. The experimental study complemented these findings by employing a middle cerebral artery occlusion (MCAO) model in rodents, closely mimicking clinical stroke conditions and enabling a controlled investigation of BBB permeability changes. By comparing different rat strains, we identified significant variations in cerebrovascular responses, infarct size, and survival rates. Fluorescence spectrometry quantified BBB permeability by measuring Evans Blue (EB) extravasation, providing spaciotemporal evaluation of BBB disruption. Utilizing MRI, we assessed water diffusion abnormalities, offering insights into tissue integrity, edema formation, and the extent of ischemic damage. The combined clinical and experimental approach enhances our understanding of BBB disruption in ischemic stroke and its long-term consequences. The findings provide valuable markers for early detection of BBB dysfunction and contribute to the advancement of precision medicine in stroke care, emphasizing the importance of BBB integrity in optimizing patient outcomes and reducing post-stroke complications.

Keywords

blood-brain barrier, ischemic stroke, MRI, cerebral ischemia, vascular permeability, MCAO, neurovascular unit, post-stroke epilepsy, BBB disruption, experimental stroke model.