Volume expansion

Volume expansion and hypertension are widely used for the hemodynamic management of patients with subarachnoid hemorrhage.

Hemorrhagic shock (HS) is one of the severe type of traumatic brain injury complications (TBI) that doubles mortality due to severely compromised microvascular cerebral blood flow (mvCBF) and oxygen delivery reduction, as a result of hypotension. Volume expansion with resuscitation fluids (RF) for HS does not improve microvascular CBF (mvCBF); moreover, it aggravates brain edema. Bragin et al. showed that the addition of drag-reducing polymers (DRP) to crystalloid RF (lactated Ringer's) significantly improves mvCBF, oxygen supply, and neuronal survival in rats suffering TBI+HS.

They compared the effects of colloid RF (Hetastarch) with DRP (HES-DRP) and without (HES). Fluid percussion TBI (1.5 ATA, 50 ms) was induced in rats and followed by controlled HS to a mean arterial pressure (MAP) of 40 mmHg. HES or HES-DRP was infused to restore MAP to 60 mmHg for 1 h (prehospital period), followed by blood reinfusion to a MAP of 70 mmHg (hospital period). In vivo two-photon microscopy was used to monitor cerebral microvascular blood flow, tissue hypoxia (NADH), and neuronal necrosis (i.v. propidium iodide) for 5 h after TBI+HS, followed by postmortem DiI vascular painting. Temperature, MAP, blood gases, and electrolytes were monitored. Statistical analyses were done using GraphPad Prism by Student's t-test or Kolmogorov-Smirnov test, where appropriate. TBI+HS compromised mvCBF and tissue oxygen supply due to capillary microthrombosis. HES-DRP improved mvCBF and tissue oxygenation ($p < 0.05$) better than HES. The number of dead neurons in the HES-DRP was significantly less than in the HES group: 76.1 ± 8.9 vs. 178.5 ± 10.3 per 0.075 mm3 ($P < 0.05$). Postmortem visualization of painted vessels revealed vast microthrombosis in both hemispheres that were 33 ± 2% less in HES-DRP vs. HES ($p < 0.05$). Thus, resuscitation after TBI+HS using HES-DRP effectively restores mvCBF and reduces hypoxia, microthrombosis, and neuronal necrosis compared to HES. HES-DRP is more neuroprotective than lactated Ringer's with DRP and requires an infusion of a smaller volume, which reduces the development of hypervolemia-induced brain edema [1)]

1)
Bragin DE, Bragina OA, Berliba L, Kameneva MV, Nemoto EM. Addition of Drag-Reducing Polymers to Colloid Resuscitation Fluid Enhances Cerebral Microcirculation and Tissue Oxygenation After Traumatic Brain Injury Complicated by Hemorrhagic Shock. Adv Exp Med Biol. 2021;1269:283-288. doi: 10.1007/978-3-030-48238-1_45. PMID: 33966231.