

Drag-reducing polymers

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 Dil 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 mm^3 ($P < 0.05$). Postmortem visualization of painted vessels revealed vast microthrombosis in both hemispheres that were $33 \pm 2\%$ 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⁾

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5: Bragin DE, Kameneva MV, Bragina OA, Thomson S, Statom GL, Lara DA, Yang Y, Nemoto EM. Rheological effects of drag-reducing polymers improve cerebral blood flow and oxygenation after traumatic brain injury in rats. *J Cereb Blood Flow Metab.* 2017 Mar;37(3):762-775. doi: 10.1177/0271678x16684153. Epub 2016 Dec 22. PMID: 28155574; PMCID: PMC5363490.

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Cerebral Microcirculation Using Rheological Modulation by Drag- Reducing Polymers. Adv Exp Med Biol. 2016;923:239-244. doi: 10.1007/978-3-319-38810-6_32. PMID: 27526149; PMCID: PMC4988339.

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1)

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