Mean arterial pressure required for maintaining patency of extracranial to intracranial bypass grafts: an investigation with computational hemodynamic models. Case series

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Abstract

Background: Maintaining flow in a newly established high flow bypass into the intracranial circulation may be threatened by low blood pressure.

Objective: To identify mean arterial blood pressure below which early graft failure may ensue.

Methods: Computational fluid dynamic blood flow simulation and Doppler ultrasound derived velocities were combined to study twelve patients with common carotid to intracranial (internal carotid in 9 and middle cerebral in 3) arterial brain bypass with interposition saphenous vein. Patients underwent carotid duplex and high-resolution Computational tomographic angiography examination to source the necessary data. A mean time-averaged pressure gradient across both anastomosis of the graft was then calculated.

Results: The bypass graft mean blood flow +/- standard deviation was 180.3+/-76.2 ml/min (95% CI: 132-229). The mean time-averaged pressure gradient across the bypass graft was 10.2+/8.7 mmHg (95% CI: 4.6-15.7). This compared with a mean pressure gradient on the contralateral carotid of 21.7+/13.8 mmHg. From these data, the minimum mean systemic pressure necessary to maintain graft flow of at least 40ml/min was 61.6 +/- 2.31 mmHg, and the mean peak wall shear stress at the proximal anastomosis was 0.8+/0.7 Pa (95% CI: 0.3-1.2).

Conclusion: Early postoperative mean arterial pressure below approximately 60 mmHg may induce blood flow in the bypass to fall below 40ml/min, a flow below which low shear stress may lead to early graft occlusion.

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