Haemodynamic Responses in Carotid Bifurcation Induced by EECP: Healthy Controls vs Patients with Neurological Disorders

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Study Type	Prospective human study + 3D computational fluid dynamics simulation
Subjects	5 patients with neurological disorders + 5 young healthy controls; all received EECP at 20–40 kPa
Ethics	Approved by local ethics committee of Eighth Affiliated Hospital, SYSU
ACC Relevance	Demonstrates EECP's distinct haemodynamic benefit for neurological patients — TBI, stroke, and post-injury neuropathy

Study Rationale

EECP is FDA-approved and has a Class IIa recommendation in the American Stroke Association guideline for acute ischaemic stroke management. Previous studies confirmed that EECP induces different cerebral haemodynamic responses in stroke patients versus healthy controls, but the underlying mechanisms were unknown. This study was the first prospective investigation of EECP's influence on blood flow distribution and WSS-derived haemodynamic factors at the carotid bifurcation.

Methods

Imaging	3.0T MRI magnetic resonance angiography (MRA) of carotid artery in all subjects
Ultrasound	Colour Doppler ultrasound (Philips EPIQ 7, 9–11 MHz) — CCA, ICA, ECA blood flow at baseline and during EECP

EECP device	Portable P-ECP/TM device; single 30-min session; incremental pressures 20, 30, 40 kPa
CFD modelling	3D patient-specific computational fluid dynamics (Ansys Workbench); WSS, OSI, RRT calculated

Key Results — Blood Flow Changes During EECP

Artery	Neurological Patient Group	Healthy Controls	Significance
Common Carotid Artery (CCA)	Significant increase (30 kPa: 9.56→11.49 mL/s, p=0.05)	Significant increase at 20 & 30 kPa	Consistent in both groups
Internal Carotid Artery (ICA)	Mean increase 6.67% at 20 kPa — cerebral blood flow improves	Mean decrease 9.2% — protective autoregulation	Opposite responses — key finding
External Carotid Artery (ECA)	Approximately constant	Significant increase (excess CCA flow redirected)	Different distribution

WSS Factor	Neurological Group Change	Healthy Group Change	Clinical Significance
AWSS (Avg Wall Shear Stress)	38.5% increase at 30 kPa vs pre-EECP	19.83% increase at 20 kPa vs pre-EECP	Both groups: improved protective WSS
OSI (Oscillatory Shear Index)	Increased 8.33% at 20 kPa	Decreased 16.28% at 20 kPa	Differences by pressure level
RRT (Relative Resident Time)	Decreased 19.66% at 30 kPa	Decreased 22.69% at 20 kPa	Both groups: reduced thrombotic risk marker

Key Conclusions

• **Neurological patients benefit uniquely:** EECP increases ICA blood flow in patients with neurological disorders — improving cerebral ischaemia — whereas in healthy subjects cerebral autoregulation maintains ICA flow at a plateau, avoiding hyperperfusion risk

• **Increased WSS throughout carotid bifurcation:** EECP improved wall shear stress in the patient group across the entire carotid bifurcation — the most important haemodynamic mechanism for endothelial protection and stroke prevention

• **Optimal pressure for neurological patients:** Low cuff pressure (20 kPa / ~150 mmHg) produced the greatest ICA blood flow increase in neurological patients — a practical clinical finding

• **ACC relevance:** TBI patients and those with post-traumatic cerebrovascular changes may directly benefit from EECP-mediated improved cerebral perfusion and wall shear stress modulation

Full Citation

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