External counterpulsation improves cerebral perfusion velocity in acute stroke patients and may stimulate collateral artery growth. However, whether at-risk patients with high-grade carotid artery disease may benefit from counterpulsation in regards to increased blood flow and tissue oxygenation need to be validated by neuroimaging techniques.

**Purpose:** This study investigates the short-term effect of counterpulsation on cerebral oxygenation and hemodynamics in patients with asymptomatic unilateral chronic severe ICA stenosis (>70%) or occlusion.

**Methods:** Twenty-eight patients (71 ± 6.5 years, 5 women) were randomized to receive 20 min active counterpulsation followed by sham counterpulsation or vice versa. Cerebral blood flow velocity (CBFV), tissue oxygenation index (TOI, measured over the bilateral prefrontal cortex by near-infrared spectroscopy) and cerebral hemodynamic parameters, such as relative pulse slope index (RPSI), were monitored.

**Results:** Ipsilateral mean CBFV (ΔVmean ±3.5±1.4 cm/s) and tissue oxygenation (ΔTOI, +2.86±0.8) increased significantly during active counterpulsation compared with sham counterpulsation (ΔVmean ±1.1±1.1 cm/s; p=0.01; ΔTOI, +1.25±0.65; p=0.01). On contralateral sides active counterpulsation and sham counterpulsation had no effect on CBFV (ΔVmean ±0.03±1.72 cm/s) and tissue oxygenation (ΔTOI, +0.63±0.72; 1.0±0.58±0.6). During active counterpulsation, early dynamic changes in ΔRPSI of the ipsilateral CBFV signal predicted an improved tissue oxygenation during active counterpulsation (RPSI adjusted odds ratio, 1.179; 95% confidence intervals, 1.01–1.51), while baseline cerebrovascular reactivity to hypercapnia failed to show such an association.

**Conclusions:** In patients with high-grade carotid disease, ipsilateral cerebral oxygenation and blood flow velocity is increased by counterpulsation. This is a necessary condition for the stimulation of regenerative collateral artery growth. This study provides a rationale for further clinical investigations on long-term effects of counterpulsation on cerebral hemodynamics and collateral growth.

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