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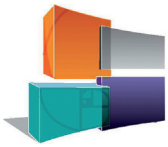

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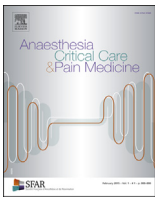

Letter to the Editor

Increased middle cerebral artery Doppler velocities after stroke thrombectomy performed under general anaesthesia: A pilot monocentric retrospective study

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Recent randomised clinical trials have established the efficacy and the safety of mechanical thrombectomy (MT) in patients with acute ischaemic stroke (AIS) [1]. After recanalization, cerebral blood flow (CBF) can increase above baseline on the side of the lesion. Perfusion CT and MRI showed post-ischaemic hyperperfusion in both experimental and human models [2,3]. An increased CBF may cause cerebral vasogenic oedema in this context of potential blood barrier rupture and can lead to haemorrhagic transformation and poor functional outcome if not managed properly. However, CT and MRI are costly and time-consuming procedures, which are not suitable for a real-time monitoring of cerebral perfusion. At the time, there is no description of haemodynamic conditions following recanalization of AIS by using Transcranial Doppler (TCD), even though TCD is a low-cost, reproducible and non-invasive tool. Therefore, we conducted a study to describe middle cerebral artery (MCA) velocities monitored by TCD after MT for AIS of anterior circulation.

After approval by the "Commission nationale informatique et libertés (CNIL)", we analysed the data of patients admitted in intensive care unit (ICU) after MT for AIS from January 2014 to December 2015. Patients were admitted in ICU when they had undergone general anaesthesia (GA). The choice of anaesthesia was a team decision based on clinical conditions such as agitation or consciousness impairment. We included selected patients with MT performed under GA for AIS of anterior circulation with a successful reperfusion assessed by the Thrombolysis in Cerebral Infarction (TICI; scores range from 0 to 3, with a TICI $\geq$ 2b corresponding to a successful reperfusion). We excluded patients with AIS in other territories (i.e., posterior circulation) and AIS of anterior circulation with incomplete recanalization (TICI $<$ 2b). The severity of the stroke was measured by using the National Institutes of Health Stroke Scale score (NIHSS; scores range from 0 to 42, with higher scores indicating a severe deficit). The use of intravenous thrombolysis was recorded.

TCD monitoring was performed daily from day 1 to day 5. We considered day 1 as the 24 hours after MT. The pulsed transcranial Doppler (LOOKI^{TM}, Atys medical, Soucieu-en-Jarrest, France) was chosen to monitor systolic (SV), mean (MV) and diastolic (DV) velocities in MCA (expressed in cm/s), both in the ipsilateral and the contralateral side of the lesion. We calculated the pulsatility index (PI) as the difference between systolic and diastolic flow velocities divided by the mean velocity [(SV – DV)/MV]. The physician in charge performed the measurements for an individual patient. At each Doppler measurement, the use of antihypertensive drugs [alpha 1 blocker, Uradipil (Eupressyl®, Takeda, Japan) and/or calcium channel blocker, Nicardipine (Loxen®, Novartis Pharma SA, Switzerland)], the systolic, diastolic and mean arterial pressures as well as the arterial partial pressure of carbon dioxide ($PaCO_2$) and the haemoglobin level (Hb) were recorded. The Functional outcome was assessed during a dedicated neurological examination at month-3 by using the modified Rankin scale (mRS; scores range from 0 to 6, with a functional independence defined as a score of 0, 1 or 2).

The quantitative variables were expressed as median and 25th–75th percentiles, and qualitative variables as frequency and percentage. We used non-parametric Wilcoxon and Friedman tests (XLSTAT^{TM}, Addinsoft, Version 2015.1.03.16130, Paris, France). A P-value $<$ 0.05 was considered significant.

Twenty-six patients were admitted in ICU after MT for AIS between January 2014 and July 2015. Thirteen patients were excluded from the analysis because of inadequate TCD window (3 patients), occlusion of basilar artery (1 patient), carotid dissection with failure of reperfusion (3 patients), vasculitis (1 patient), spontaneous reperfusion before MT (1 patient) and incomplete reperfusion (4 patients, including 2 with malignant AIS leading to decompressive craniectomy and death). We included 13 patients, aged 66 (53–70) years, with a NIHSS at 18 (13–21) and 10 were males (76.9%). None of these patients had acute or chronic heart failure with impaired left ventricular ejection fraction. Seven patients (53.8%) received intravenous thrombolysis before MT. The technique of retrieval stents was used in all patients.

The blood flow velocities at ICU admission after MT (Fig. 1) were symmetric between ipsi- and contralateral MCA. Then ipsilateral velocities increased significantly from day 1 to day 5 (SV, MV and DV), whereas only contralateral SV velocities did. Ipsilateral velocities (SV, MV and DV) were significantly higher than contralateral velocities at day 2, and SV at day 3. Four patients (30.7%) remained mechanically ventilated at 48 hours after MT, and two of them until day 5. The blood pressure has not changed significantly during the study period, but the medical staff decided the administration of antihypertensive drugs for 10 patients (76.9%). There was no significant variation of the $PaCO_2$, but Hb decreased significantly at day 1 and then remained stable. Three patients were discharged from ICU before day 3, six experienced pneumonias and two pulmonary embolisms. Favourable outcome at month-3 was observed in 10 patients (77%).

Although MCA blood flow velocities were symmetric at ICU admission, we measured a significant increase of both systolic and diastolic cerebral velocities only on the ipsilateral side of the lesion

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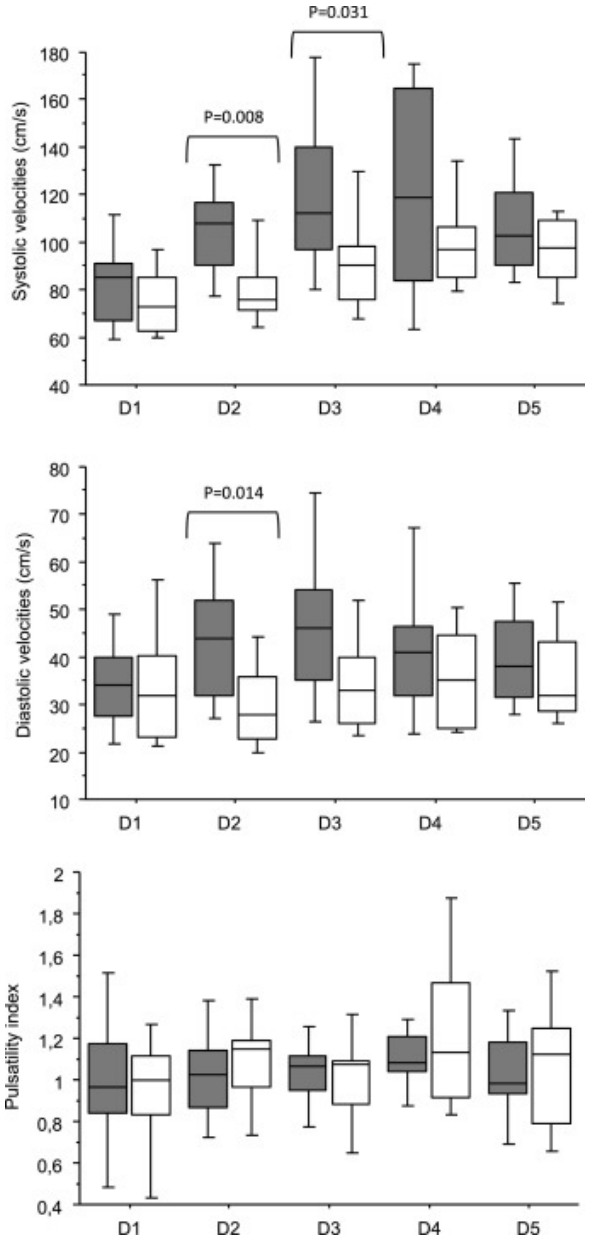

Fig. 1. Evolution over the time of the systolic, diastolic blood flow velocities and the pulsatility index (PI, calculated as follow [(SV − DV)/MV]) in ipsilateral (gray bars) and contralateral (white bars) middle cerebral arteries (MCA). Velocities are expressed in cm/s. The effectives were 13 patients at day 1 and day 2, 10 at day 3, 9 at day 4, and 8 at day 5. The Friedman test was significant for ipsilateral VS (P = 0.009) and VD (P = 0.048), and for contralateral VS (P = 0.0424).

within the first days after MT. These changes may be partly related to the awakening process or inter-observer variability, although similar changes were not observed on the contralateral side, and neither $PaCO_2$ nor Hb had changed. This pattern may reflect post-recanalization hyperperfusion, also because of the absence of PI variation. This finding is consistent with larger imaging studies reporting hyperperfusion after recanalization of stroke by using perfusion CT or MRI. However, our preliminary result is the first description of such an asymmetry using a TCD at bedside. TCD is a widely used tool that allows a real-time monitoring of cerebral haemodynamic conditions and TCD may be useful to address the issue of the optimal blood pressure management after MT for AIS [4,5]. The optimal blood pressure would limit high velocities related to hyperperfusion, without hampering the perfusion of the healthy hemisphere.

Our study constitutes a preliminary report on cerebral haemodynamic conditions after MT under GA that needs to be further characterised in larger perfusion imaging.

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Disclosure of interest

The authors declare that they have no competing interest.

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