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Cerebral Blood Flow Regulation: Recent Advances in Anaesthesia and Future Challenges

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In the last 5-7 years, a large number of studies have used neurosonological techniques to assess effects of anaesthetic agents and techniques on cerebral blood flow regulation. Different outcome variables have been used and these include the following.·
Indices of cerebral autoregulation· Cerebral vascular reactivity to carbondioxide· Non-invasive Cerebral Perfusion Pressure·
Zero Flow PressureDespite limitations of the methodology employed, a number of important observations have been made that can be generalised in the following points.1. Anaesthetic agents have either dilatory or constrictive influences on cerebral vessels – these effects can be direct effects, indirect metabolic effects, or both.2. Different anaesthetics affect cerebral autoregulation differently - these differential effects also depend upon the dose, technique and level of carbon dioxide.3. Anaesthetic agents affect zero flow pressure and cerebral perfusion pressure – these effects vary with the choice of anaesthetic agent.These advances point to how cerebral blood flow regulation can be maintained during anaesthesia – the challenge for the future is to ascertain whether preservation of cerebral blood flow regulation during anaesthesia translates into better patient outcome.

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The Degree of Recanalization and Transcranial Color Coded Doppler Ultrasound: subgroup of the ELIGIBLE study

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Background and Purpose: We investigated whether transcranial color coded Doppler (TCCD) findings may be considered predictive factors of stroke outcome, in a subgroup of patients recruited in ELIGIBLE study.
Methods: We evaluated 54 patients (age 40-80 years) with acute strokes of the anterior circulation, recruited in the ELIGIBLE Study, between September 2004 and April 2005. 7 patients presented internal carotid artery occlusion (ICA), 10 patients had ICA plus MCA plus ACA occlusion, T occlusion (siphon, ACA and MCA) was found in 5 patients, 8 patients had M1-MCA occlusion and 10 M2-MCA occlusion. 14 patients were treated with endovenous t-PA within 3 hours from symptoms, 4 were submitted to ICA surgery and 36 received conventional therapy. Neurological examination and TCCD were performed at admission, at 3-6 hours, 24-36 hours, at day 5 after therapy and at 3 month from discharge. The clinical improvement was considered as a NIHSS score reduction of 2 points. TCCD was performed with II generation contrast agents (SonoVue, Bracco) to improve the morphological MCA artery study. MCA stenosis morphology was classified in monofocal stenosis with and without post-stenotic dilatation, plurifocal stenosis and tubular stenosis.
Results: In the 7 patients with an isolated ICA occlusion, there was no change in the state of vessel patency in 6 patients, regardless of any treatment administered (acetylsalicylic acid [ASA], rtPA, ASA + low molecular weight heparin [LMWH]). The remaining one presented a thromboembolic occlusion and he underwent to a successful emergency carotid endarterectomy (CEA), with a complete recovery. In the 10 patients with combined occlusions of ICA, MCA, and ACA, the ICA remained occluded in all cases, while the TCCD showed recanalization of the MCA in only 4 patients. In one case, there was a partial recanalization 24-36 h after administering the treatment (ASA), with a low flow rate in the M1 segment, while M2 remained occluded; after 5 days, there was evidence of the recanalization of the whole MCA. In another patient, the MCA had reopened completely 24-36 h after the administration of treatment (ASA + LMWH), while a stenosis of the ACA returned to normal after 3 months. One patient had an occlusion due to an acute aortic dissection, in which the MCA completely recanalized 24-36 h after starting intravenous heparin infusion, with a residual ACA stenosis that returned to normal at 3 months. In the last patient, the M1 segment was found completely recanalized 5 days after administering treatment (ASA + LMWH), with a residual occlusion of M2 that persisted beyond the 3-month follow-up. In all patients, the NIHSS score remained the same or worse, with the exception of the patient with an aortic dissection, who experienced a marked improvement at 3 months, probably due to the young age.Among the 8 patients with M1 occlusions, the vessel reopened within 3-6-h from treatment administration in 4 cases (rtPA in 2, ASA in 1 and ASA+LMWH in 1); recanalization was complete in 3 (2 on rtPA and 1 on ASA) and there was a decrease of at least 2 points in the NIHSS score. The fourth patient had only a partial recanalization and the residual stenosis remained unchanged until the fifth day, but 3 months later we documented a normal flow rate. In one patient treated

with ASA, there was evidence of a complete reopening of the M1 segment with a residual stenosis in M2 after 24-36 h, but the NIHSS score deteriorated and follow-up brain CT (which had been negative on admission) revealed extensive homolateral frontoparietal ischemia. Finally, 3 patients (2 treated with rtPA and one with ASA) revealed no signs of any recanalization and their NIHSS score remained the same or became worse. One patient treated with rtPA died of hemorrhage. In 10 patients, TCCD showed a distal MCA occlusion (M2): 6 of these were recanalized 3-6 h after treatment (rtPA) and this recanalization was complete in 4 cases and partial in 2 (and completed at 3-month follow-up). One patient treated with ASA was found recanalized after 3 months, while the vessels remained occluded in the remaining 3 cases (2 treated with rtPA and 1 with ASA). The NIHSS score improved in all recanalized cases with the exception of the one patient who still had extensive ischemia throughout the MCA region at follow-up CT scan, despite thrombolytic treatment.Of the 5 patients with T occlusions, 3 were treated with CEA (associated with locoregional urokinase in 2 cases) and experienced siphon and ACA recanalization, with residual MCA occlusion, at 3-6 h; then the MCA was fully recanalized within 24-36 h in one case, another had residual MCA stenosis at 3-month follow-up and the third patient died. In the latter cases (1 rtPA and 1 ASA) the occlusion did not change during the follow-up.The different segments of the MCA behaved differently in the intracranial stenosis subgroup: in the M1 segment, the flow had returned to normal in 2 cases (ASA) after 24-36 h, but the NIHSS score did not change with respect to the baseline. In the other cases (2 rtPA, 1 oral anticoagulant therapy and 3 ASA), the stenosis remained the same after 3 months. On the other hand in the M2 segment the flow rate had returned normal in all cases after 3 months, and already after 3-6 h in 3 cases (1 rtPA and 2 ASA), after 24-36 h in 1 (i.v. heparin) and after 5 days in 1 (ASA). In all these patients, the NIHSS score improved at 3-month follow-up. Atrial fibrillation was more frequent in the groups of MCA occlusion and stenosis and it is associated with a good outcome.

Conclusion: We may conclude that site of occlusion, speed of recanalization, residual stenosis and the presence of atrial fibrillation predict with high accuracy short-term stroke outcome indipedently from therapy used. TCCD and new ultrasound techniques with contrast agents may be considered useful, inexpensive and non-invasive methods to predict outcome in acute stroke patients.

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QontraXt®: application of a new Ultrasound Perfusion Imaging software in acute stroke

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Quantification of blood volume and flow is crucial for determining areas of different perfusion in whole organ/tissue due to impairment of blood supply or to characterize different lesions depending on the anatomical and functional aspects of vascular physiologyQONTRAXT is an user-friendly research software developed by AMID® (Rome, Italy) in cooperation with Bracco® Imaging R&D (Milan, Italy) , which has been designed for the evaluation of tissue perfusion obtained after Contrast-Enhanced Ultrasound (CE-US) examination. It has been specifically designed for radiological ultrasound applications and, at the present, it runs off-line on personal computer equipped with standard O.S. (Windows XP, Windows 2000, Windows Me, or Windows 98). The software analyzes the signal intensity changes induced by the i.v. injection (bolus and infusion) of microbubble-based ultrasound contrast agents over time providing pixel-by-pixel color-coded maps of the haemodynamic parameters of the organ/structure under investigation, and precisely:
regional blood volume (rBV)
regional blood flow (rBF)
mean-transit-time (MTT)
perfusion index (PIND)
QontraXt is able to process CE-US cine-loop performed using both the First-Pass technique (i.e. fast bolus injection of microbubbles, a.k.a. wash in-wash out curve) or the so called Disruption/Replenishment method (i.e. constant rate infusion of the contrast agent).
We try to apply this new Ultrasound Perfusion Imaging (UPI) parametric software in the off-line analysis in our acute MCA stroke patients. We performed UPI with the bolus track technique, with i.v. bolus injection of a second generation UCA, Sonovue® (Bracco International BV). The technical modality for UPI was a Power Modulation contrast imaging, using a low mechanical index (MI 1.0). The software converted the gray scale images in a parameter color-coded qualitative maps, then it allowed an off-line pixel-by-pixel analysis of time-intensity curves (TIC).
The resulting color-coded parametric maps allowed an immediate, visual assessment of the perfusion properties over the entire selected region of interest. Once the parametric maps had been generated, Qontrast allowed the pixel-by-pixel quantitative analysis of perfusion