Phase contrast MRA measurements of total cerebral blood flow in newborns.

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Introduction

In newborns an adequate blood supply to the brain is crucial to prevent ischemia and infarction. Thusfar cerebral blood flow measurement studies in newborns have been performed with 133Xenon, positron emission tomography and MRI/CT methods with contrast injection. Furthermore, color Doppler flow measurements is a method capable to perform bedside measurements of flow velocities, but quantitative assessment of flow volumes with Doppler is difficult due to the small diameter of the feeding vessels in newborns. A recent study in cases after extracorporeal membrane oxygenation (ECMO), with post-ECMO occlusion of the internal carotid artery, has presented the potential of phase contrast MR Angiography flow measurements as a fast and non-invasive method to measure the total cerebral flow in ml/min through the internal carotid and basilar arteries (Hendrikse, Stroke 2006; Figure 1). Still no reference values for phase contrast MRA flow measurements of the brain feeding arteries at the skull base are available and the relations between phase contrast MRA flow measurements and postmenstrual age and weight are unknown.

Methods

In thirty-two newborns with a clinical reason to perform MRI scans, phase contrast MRA flow volume (ml/min) data were acquired. The postmenstrual age range was between 31-55 weeks, the weight range was between 1050-5858 gram. All experiments were performed on a 1.5 T Philips Intera Imager (Philips Medical Systems, Best, The Netherlands). On the basis of a localizer MRA slab in the sagittal plane, a 2-dimensional phase contrast MRA slice was positioned at the level of the skull base to measure the volume flow in the internal carotid arteries and the basilar artery. The velocity encoding (VENC) was set to 30cm/sec to adapt to the lower velocity values in newborns. Other parameters of the nontriggered phase contrast sequence were: repetition time [TR], 16 ms; echo time [TE], 9 ms; flip angle 7.5°; slice thickness, 5 mm; field of view, 250×250 mm; matrix size, 256×256; 8 averages. Scan time for the phase contrast MRA scan was 38 seconds (Bakker, MRI, 1996). Total cerebral blood flow values were calculated by adding the flow volume values of the left and right internal carotid arteries and the basilar artery.

Results

Figure 2 and 3 show the relation between MRA total cerebral blood flow measurements and the postmenstrual age (R-square = 0.64, $p < 0.001$) and weight (R-square = 0.52, $p < 0.001$). MRA total cerebral blood flow increased with 6.8 ml/min per week age increase.

Discussion and conclusions

An excellent correlation was found between MRA total cerebral blood flow measurements and postmenstrual age and weight. Furthermore the flow increase of 6-7ml/min is in accordance with previous data observed in ultrasound studies, which show a flow increase of 6 ml/min per week increase in postmenstrual age (Kehrer, Lancet, 2002). An advantage of MRI examinations over ultrasound studies of total cerebral blood flow is the potential of a detailed evaluation of both brain anatomy and the cerebral hemodynamics with magnetic resonance angiography (MRA) techniques. In conclusion, the presented MRA phase contrast scan may be a simple and powerfull sequence to detect cerebral hemodynamic impairment in newborns with a decreased total cerebral blood flow.

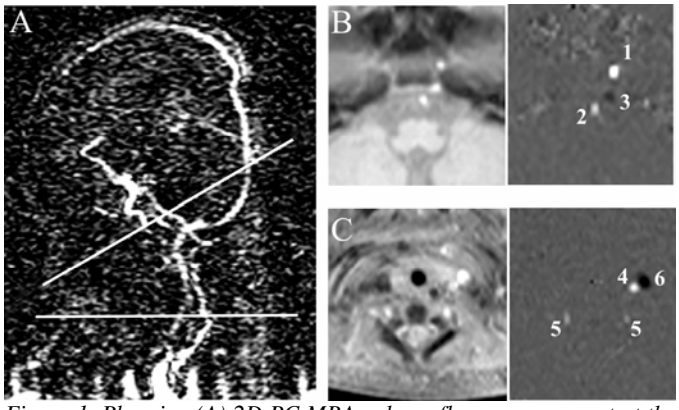

Figure 1. Planning (A) 2D PC MRA volume flow measurement at the skull base (B) and below the carotid bifurcation (C). 1: left internal carotid artery; 2: basilar artery; 3: sinus ethmoidales inferior; 4: left common carotid artery; 5: vertebral arteries; 6: left jugular vein. In this newborn the right common carotid artery was occluded after the ECMO procedure.

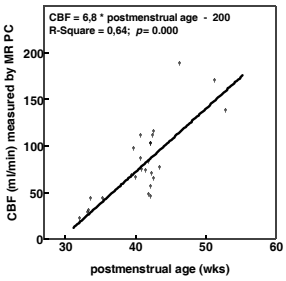

Figure 2. Correlation between MRA total cerebral blood flow measurements of the basilar artery and the internal carotid arteries at the skull base in ml/min and the postmenstrual age of the 32 newborns. A 6.8 ml/min flow increase per week was found.

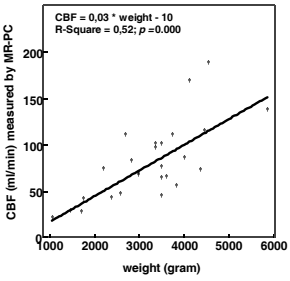

Figure 3. Correlation between MRA total cerebral blood flow measurements of the basilar artery and the internal carotid arteries at the skull base in ml/min and the weight of the newborns. A 30 ml/min flow increase per kg weight increase was found.