Influence of head posture and PC-MRI arterial flow on ASL CBF measurements in children

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INTRODUCTION

Standard implementation of MR-perfusion imaging, based upon the bolus injection of an exogenous contrast agent, provides various local microcirculation parameters such as cerebral blood flow (CBF in ml/min/100g tissue)). The implementation of this technique is not easy in pediatric populations. An alternative technique was developed without the use of exogenous agent: Arterial Spin Labeling (ASL)[1] provides theoretically absolute CBF maps. The goal of our study is to evaluate the relationship between ASL CBF and intracranial arterial inflow measured using phase-contrast sequence and the associated age-related changes in a pediatric population.

METHODS

Patients: Twenty children (3.3+/-2 years old; range: 1-8 y) who underwent MRI exam were retrospectively studied, in agreement with the local ethics board.

Imaging: 2D Cine-PC sequence with cardiac gating at C2-C3 level and 3D-FSE PCASL imaging with spiral acquisition were implemented on a 3T HDx MR Scanner (GE Healthcare, Milwaukee, WI). Acquisition parameters were:
*Gradient-echo 2D Fast Cine PC: TR 10-18 ms, TE 4-8 ms, 2 View per segment, 1 Nex, FOV 14x10 to 17x14 cm², Slice thickness 5 mm, Matrix 256x128,Venc 80 cm/s. *3D-FSE Pulsed-Continuous ASL : TR 4500 ms, TE 10 ms, FOV 24x24 cm², Slice thickness 4 mm, Spiral trajectory: 512 points-8 arms, TI 1025 ms (<2 years old) 1525 ms (>2 years old).

Data analysis: Cerebral volume index (CVI): calculated as the volume of the reference ellipsoid fitting the brain surface. Head inclination (Angle): angle between the ASL axial sections and the AC-PC plane defined on a sagittal view.
Total arterial inflow Qa was obtained by summation of the internal carotids and vertebral arteries flows[2]. Blood flow analysis was performed using a semiautomatic software[2]: arterial inflow Qa (ml/min) was calculated from 32 images covering the cardiac cycle. ASL data analysis was performed using *Ready View* (GE *Advantage Workstation)*: global mean CBF (ml/min/100g) at midbrain level was measured and then volumic CBF =CBFv= CBFxCVI (ml/min) was calculated.

Statistical analysis: Pearson correlation tests were used.

RESULTS AND DISCUSSION

The ratio (CBFv/Qa) was negatively correlated to the head inclination (r^2=0.68, p<0.001). CBFv was strongly correlated to intracranial arterial inflow Qa especially when normalized with the cardiac frequency N ((r^2=0.65, p<0.001). An angular correction [cos(Angle)] significantly improve the correlations between the explored parameters. CBF was not significantly correlated with subject's age whereas Qa, CBFv and Qa/N were (r^2= 0.1, 0.58, 0.65 and 0.71, respectively).
Various studies[3-5] showed the variability of ASL measurements under the influence of several parameters such as: labeling efficiency, changes in blood T1, arterial transit time or selection of inversion time TI. In this study, we observed the significant influence of the head position which is a critical parameter in children population especially under anesthesia. The hemodynamic influence is also highlighted through the cardiac frequency.

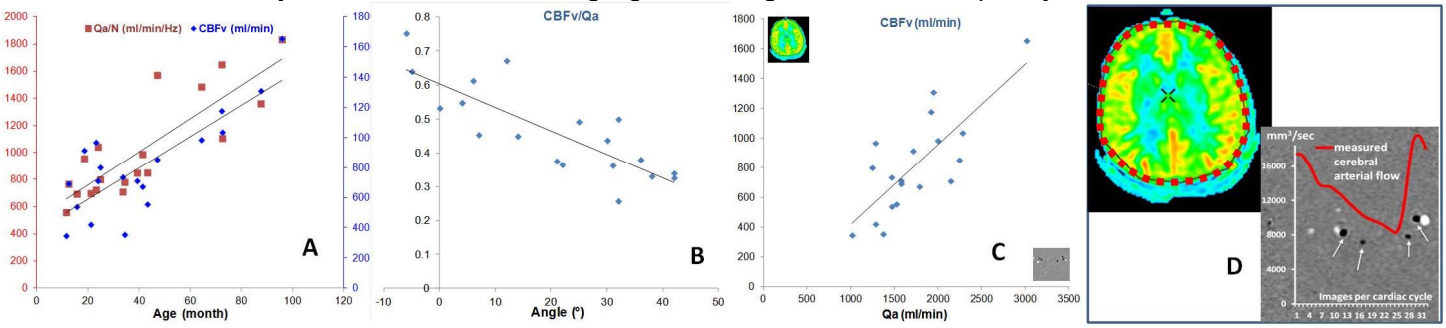

Figure 1: (A):*Evolution of CBFv and Qa/N as a function of age. (B):Influence of the head inclination on the ratio CBFv/Qa. (C):Correlation between CBFv and Qa. (D): ASL CBF map at midbrain with the considered global ROI(dotted line). Arterial flow curve superimposed on phase image at C2-C3 level showing the arterial blood vessels (arrows).*

CONCLUSION

Our study showed the correlation between the global cerebral ASL perfusion and the reference arterial inflow measured using PC-MRI. The influence of the head inclination is not negligible. Owing to the inclusion of a Cine-PC sequence, knowledge of cervical arteries' flow could improve the accuracy of ASL data.

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