Effects of Propofol on Cerebral Perfusion of White Matter versus Gray Matter in Pediatric Brain.

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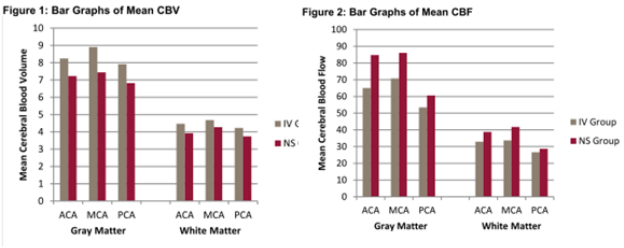
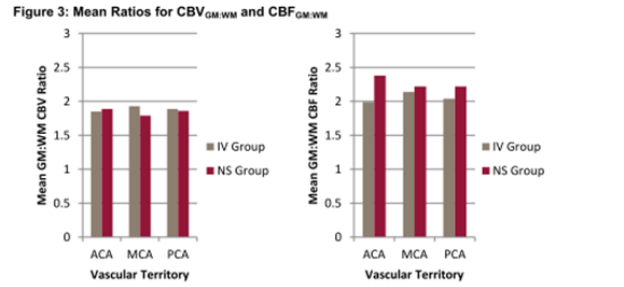
Purpose: Significant alterations in cortical cerebral blood flow (CBF) and cerebral blood volume (CBV) in children sedated for dynamic susceptibility contrast (DSC) perfusion MRI with IV propofol have been described (Harreld et al, RSNA 2011), in keeping with known effects of propofol on vessels and cerebral metabolic rate (CMR)[1]and potentially impacting interpretation of MR perfusion data. Given that cortical CMR is three-fold greater than white matter (WM) CMR[1] and that CMR and CBF are tightly coupled in the usual state, effects of sedation on gray matter (GM)and WM perfusion may differ. Because DSC perfusion is not considered absolutely quantitative, ratios of tumor to normal-appearing WM are often used to quantify CBV or CBF. If WM perfusion is altered with anesthesia, these ratios may not be reliable. Age-related decreases in GM/WM ratio have also been described, further complicating analysis[2,3]. We retrospectively reviewed DSC MR perfusion imaging in a pediatric neuro-oncology population to investigate whether WM CBF and/or CBV significantly differ between children sedated with propofol (IV) and those not sedated (NS) at MRI and, if so, whether GM/WM ratio would provide a more robust basis for comparison.

Materials & Methods: A retrospective review of DSC MR perfusion images acquired supratentorially (Magnevist IV contrast, 0.8-1 cc/sec) in 38 pediatric patients without visible supratentorial brain abnormalities (age range 1.8 to 18 years, mean age 9.7 years) sedated with IV propofol (IV, n=19, mean age 5.3 years; 13/19 had RT) or non-sedated (NS, n=19, mean age 14.2 years; all had RT) underwent segmentation[4] of GM and WM. Anterior cerebral artery (ACA), middle cerebral artery (MCA) and posterior cerebral artery (PCA) territorial GM,WM and GM/WM CBF and CBV were statistically compared using Wilcoxon Signed Rank for within group comparison and Wilcoxon Rank Sum test for between group comparison. Multiple linear regression analysis with CBF and CBV as dependent variables and independent variables age, hematocrit (Hct), $ETCO_2$ (IV only), weight, gender, and RT were performed to identify influential factors in GM,WM and $CBF_{GM/WM}$ and $CBV_{GM/WM}$ in each group by vascular territory.

Results: CBF_{GM} and CBV_{GM} were ~2x greater than CBF_{WM} and CBV_{WM} in all territories in both groups ($p < 0.0001$). Though ACA and MCA CBF_{GM} were greater in NS than IV (p=0.026, 0.049); only MCA CBF_{WM} was greater in NS than IV (p=0.041). MCA CBV_{GM} was greater in IV than NS (p=0.034) while IV CBV_{WM} was greater than NS only in the ACA territory (p=0.0479). Although greater ACA $CBF_{GM/WM}$ in NS approached significance (p=0.0505), only PCA $CBF_{GM/WM}$ was greater in NS than IV (p=0.0167). There was no significant difference in $CBV_{GM/WM}$ between groups and across vascular territories.





In the **NS** group, ACA CBV_{GM} decreased slightly with weight (β= -0.0700, p=0.0159); once weight was accounted for, there was no additional influence by age or Hct in any vascular territory. There was no significant influence on CBF_{WM} or CBV_{WM} by age, weight, or Hct. ACA $CBV_{GM/WM}$ decreased slightly with age (β_{ACA}=-0.098, p=0.0356) and increased slightly with Hct (β_{ACA}= 0.0626, p=0.0382) with no additional influence by weight or gender in any vascular territory.

In the **IV** group, CBV_{GM} increased with weight in ACA, MCA and PCA territories (p=0.0004, p<0.0001, p=0.031) CBF_{GM} increased with weight in ACA and MCA territories (p=0.007, 0.033); once weight was considered, there was no additional influence by age, gender, Hct, or RT. Only ACA CBV_{WM} increased with weight (p=0.0139); MCA CBV_{WM} was greater with RT (p=0.0342). There was no additional influence by age, gender or Hct. Only MCA $CBV_{GM/WM}$ increased very slightly with age (β=0.0529, p=0.0200) with no additional influence by weight, Hct, gender or RT. Only ACA $CBF_{GM/WM}$ was smaller with RT (β= -0.5227, p=0.0009) with no additional significant influence by age, Hct, weight, or gender.

Conclusions: Differences in CBF_{WM} & CBV_{WM} between NS and IV are not the same as those in GM. Lack of significant difference in $CBV_{GM/WM}$ between groups suggests GM/WM ratio may be useful for normalization of tumor CBV measurements. However, age-related increases in $CBF_{GM/WM}$ and $CBV_{GM/WM}$ in some vascular territories, contrary to expected decreases in $CBF_{GM/WM}$ with age[2,3], may influence ratio-based perfusion measures. Territorial alterations in CBF_{WM} and CBV_{WM} with propofol differed from those in GM. Weight-related trends in GM CBF and CBV do not appear to hold for WM, so may not be a valid normalization factor in WM. Although GM/WM ratio appears more robust than GM or WM measures alone, it should be used with caution pending prospective study, as alterations in age-related trends in $CBV_{GM/WM}$ may exist.

References:

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