Susceptibility Weighted Imaging based approach to ΔOEF quantification using Propofol and Midazolam as potential OEF modulators

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Target audience: Clinicians, Dentists, MRI researchers.

Purpose: Oxygen extraction fraction (OEF) represents a critical relationship between blood supply and tissue oxygen consumption in the brain. Disruption in this relationship is known to occur in a range of cerebrovascular disorders, and is therefore considered to be an important indicator of cerebrovascular health. Traditionally, the gold standard approach to OEF measurement is Positron emission tomography (PET); however in this work aim to demonstrate the use of susceptibility-weighted imaging (SWI) in the assessment of OEF in healthy sedated and non-sedated individuals.

Methods: SWI was performed using repeated phase imaging (7T GE, 3D SPGR, 512×512, 18 × 2mm slices TE 15ms, TR 22ms, scan time 2.31 min) in three subject groups: control (n=5), sedation group 1 (Propofol, n=5) and sedation group 2 (Midazolam, n=5), from which ΔOEF maps were calculated between baseline and sedation, and two periods of sedation recovery (10mins and 30 mins post injection). Group ROI’s were averaged for each slice and between groups to measure global differences in ΔOEF due to anesthesia (Fig. 1).

Results: Repeated one-way ANOVA tests showed significant main effect between groups in ΔOEF (sedation) (p<0.018) where multi-comparison tests revealed significant difference exists between control and Midazolam group means during sedation*(Table.1, Fig. 2).

Discussion: No-significant change in ΔOEF during Propofol sedation, significant reduction in ΔOEF during Midazolam sedation, and the short-term nature of cortical suppression during Midazolam sedation is in agreement with previous literature²,³,⁴.

Conclusion: Preliminary results assessing differences in OEF between anesthesia and control groups suggest that this method may be a useful tool for measuring altered OEF in the human brain. Currently we are developing a method of quantitative SWI for region specific, resting state OEF mapping, for application in clinical cases such as hemodynamic ischemia.


Table 1. Group average %ΔOEF values

<table>
<thead>
<tr>
<th></th>
<th>% ΔOEF (Sedation)</th>
<th>% ΔOEF (10min)</th>
<th>% ΔOEF (30/40min)</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.029*</td>
<td>1.5916</td>
<td>-0.3472</td>
</tr>
<tr>
<td>Midazolam</td>
<td>-9.0419*</td>
<td>-6.6684</td>
<td>-6.4387</td>
</tr>
<tr>
<td>Propofol</td>
<td>-3.4521</td>
<td>-3.3816</td>
<td>-0.5627</td>
</tr>
</tbody>
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Figure 1. Example image slice with ROIs (left) and corresponding ΔOEF map (right).

Figure 2. %ΔOEF average group values during sedation (blue), 10mins (green) and 30mins (brown) post sedation vs. non-sedated control group with equivalent scan times.