Cerebrovascular reactivity to CO2 under Propofol Anesthesia: A Systematic Review.

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Introduction
Carbon dioxide (CO2) is a potent cerebral vasodilator and manipulation of CO2 to control cerebral blood flow (CBF) and intracranial pressure (ICP) is often used during neurosurgery.

Cerebrovascular reactivity to CO2 (CVRCO2) is a defined as change in cerebral blood flow (CBF) in response to the change in PaCO2.

Propofol is a commonly used intravenous anesthetic agent during neurosurgery, but is not clear how it affects CVR.

The purpose of our study is to do a systematic review on the effects of propofol on cerebrovascular reactivity to CO2 in adults.

Materials and Methods

Search Terms:
- Cerebrovascular CO2 reactivity
- Anesthesia
- Anesthesiology
- Surgery
- Propofol

Sources:
- The Cochrane database of Systemic Reviews
- Cochrane Central Register of Controlled Trials
- Medline
- Embase

Inclusion Criteria:
- Randomised controlled trial and observational study
- The surgery under propofol anesthesia
- Adult patient population

Exclusion Criteria:
- Pediatric population.
- CVR testing during bypass period.
- Traumatic brain injury (TBI), Carotid endarterectomy.

Data collection:
- Study population, intervention, method of CO2 manipulation, method of CBF measurement.

Literature search Results

Primary search results: 1207

Non-pertinent papers- excluded by title review: 859

Papers considered for abstract and/or full text review: 422

Non-pertinent papers- excluded by abstract/full text review: 202

CVRCO2 in non-anesthetised + TBI patients: 86

CVRCO2 in children: 36

CVRCO2 Animal studies: 15

CVRCO2 under Sevoflurane and Isoflurane Anesthesia: 76

Table: CVRCO2 under Propofol Anesthesia

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Design</th>
<th>Groups</th>
<th>Sample Size</th>
<th>CVRCO2 Results and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lang (1992)</td>
<td>OBS</td>
<td>Propofol +/- N2O</td>
<td>7</td>
<td>Preserved with and without N2O</td>
</tr>
<tr>
<td>Motto (1995)</td>
<td>OBS</td>
<td>Propofol (high dose)</td>
<td>10</td>
<td>Preserved @ 250-300 µg/kg/min</td>
</tr>
<tr>
<td>Hariton (1999)</td>
<td>OBS</td>
<td>Awake vs. Propofol</td>
<td>10</td>
<td>Preserved</td>
</tr>
<tr>
<td>Fos (1992)</td>
<td>OBS</td>
<td>Propofol +/- N2O</td>
<td>7</td>
<td>Preserved with N2O</td>
</tr>
<tr>
<td>Hishinura (2004)</td>
<td>OBS</td>
<td>Stroke vs. Control</td>
<td>34</td>
<td>Preserved. No differences between the two groups</td>
</tr>
<tr>
<td>Hishinura (2003)</td>
<td>OBS</td>
<td>Young vs. Elderly</td>
<td>26</td>
<td>Impaired in elderly compared to young @ 5 µg/kg/min</td>
</tr>
<tr>
<td>Kadoi (2003)</td>
<td>OBS</td>
<td>Diabetes vs. Control</td>
<td>60</td>
<td>Impaired in diabetes in insulin treated patients</td>
</tr>
<tr>
<td>Kowarsch (2008)</td>
<td>OBS</td>
<td>Diet, OHA, Insulin</td>
<td>21</td>
<td>Preserved in diet or OHA treated patients</td>
</tr>
<tr>
<td>Steedel (1994)</td>
<td>RCT</td>
<td>Propofol vs. Midazolam</td>
<td>10</td>
<td>Preserved with both agents</td>
</tr>
<tr>
<td>Enke (1999)</td>
<td>RCT</td>
<td>Propofol</td>
<td>36</td>
<td>Preserved</td>
</tr>
<tr>
<td>Takar (2000)</td>
<td>RCT</td>
<td>Propofol +/- Ketamine</td>
<td>13</td>
<td>Preserved with both propofol, propofol with ketamine</td>
</tr>
<tr>
<td>Mezaat (2004)</td>
<td>RCT</td>
<td>Propofol +/- Clonidine</td>
<td>28</td>
<td>Preserved with both propofol, propofol with clonidine</td>
</tr>
<tr>
<td>Kadoi (2008)</td>
<td>RCT</td>
<td>Propofol vs. Dexmedetomidine</td>
<td>10</td>
<td>Impaired with both propofol and dexmedetomidine in sepsis</td>
</tr>
<tr>
<td>Kadoi (2009)</td>
<td>RCT</td>
<td>Propofol vs. Sevoflurane Young vs. Elderly</td>
<td>30</td>
<td>Preserved. Lower in elderly compared to young</td>
</tr>
<tr>
<td>Bar (2006)</td>
<td>RCT</td>
<td>Propofol vs. Isoflurane Tumor vs. Normal</td>
<td>16</td>
<td>No difference between normal and abnormal hemisphere</td>
</tr>
</tbody>
</table>

Results

- CBF is measured by using Trans Cranial Doppler (TCD) in all studies except one where Xenon clearance method was used.
- Minute ventilation is altered to manipulate the CO2 tension in most studies.
- CVR to CO2 is preserved under propofol anesthesia at varying doses from 100 to 300 µg/kg/min.
- Adding N2O, Clonidine and ketamine to propofol did not affect the CVR.
- CVR to CO2 is preserved in patients with stroke and intracranial tumors. No difference between normal and abnormal hemisphere noted.
- CVR to CO2 is preserved in patients with DM on diet control or OHA, but it is impaired in insulin treated diabetics.
- CVR to CO2 is lower in the elderly compared to younger patients. Impaired in patients with the sepsis.

Conclusions

- CVR to CO2 is preserved under propofol anesthesia at varying concentration (both low and high doses).
- CVR to CO2 is preserved in patients with stroke and intracranial pathology.
- Impaired in insulin treated diabetics and in patient with sepsis.