Anaesthesia in the Beach Chair Position

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Outline

1. Incidence of strokes during beach chair positioning (BCP)
2. Physiology of CBF in upright position
3. Monitoring for inadequate CBF
4. Management suggestions
5. Conclusions
Disclosures

• None!

"I'll need you to sign this full nondisclosure agreement."
Case Report: NSW 2011

- 50yo former rugby player died of a massive stroke during arthroscopic shoulder surgery in “beach-chair” position.
- “..caused by a failure to estimate and maintain an appropriate level of mean arterial pressure in the blood supply of the brain” *(NSW coroner)*
- recommendation that all anaesthetic departments “develop guidelines for the appropriate adjustment for the hydrostatic gradient by anaesthetists when calculating MAP for ‘beach-chair’ surgery”.

Other case reports

- 4 cases reported by Pohl & Cullen in 2005, ages 47-57
- 3 recent cases from France with GA & interscalene block, ages 54-58
- Common features: young patients, minor comorbidities & periods of intra-op hypotension.
- Morbidity presumed to be result of ischaemic stroke due to cerebral hypoperfusion.

Pohl & Cullen, J Clin Anesth, 2005
Villevieille, Ann Fr Anesth, 2012
Case: Incomplete Circle of Willis

- 50yo male, 180cm tall, smoker, Pre-op BP 110/75
- SBP @ arm = 95-100mmHg, lowest MAP=61mmHg (≈35-40mmHg @ Head)

CTA: incomplete circle of willis.

MRI @ 2 months: Left Anterior & Middle Cerebral Artery territory infarct

? ACom

? PCom

## Incidence of Brain Injury following surgery in Beach Chair Position?

<table>
<thead>
<tr>
<th>N=5177 Retrospective Series</th>
<th>BP Measurement</th>
<th>Av. Mean BP</th>
<th>Average BP Drop %</th>
<th>% Patients &gt;1 episode BP Drop &gt;40% from baseline</th>
<th>Average Hypotension Time per episode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shoulder Surgery</strong></td>
<td>A Line (heart) n=682</td>
<td>75</td>
<td>14.4</td>
<td>51%</td>
<td>16.6min</td>
</tr>
<tr>
<td></td>
<td>NIBP n=3545</td>
<td>74</td>
<td>19.3</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td><strong>Neuro Cases</strong></td>
<td>A line (heart) n=422</td>
<td>78</td>
<td>17.6</td>
<td>52%</td>
<td>16.7min</td>
</tr>
<tr>
<td></td>
<td>A Line (head) n=528</td>
<td>75</td>
<td>19.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No immediate postoperative catastrophic outcomes occurred, upper 95% CI = 7 per 10000

*Pin-On & Munis, A&A 2013*
Incidence of Intraoperative Stroke

• Survey of orthopaedic surgeons, cases > 200K
• Estimated stroke rate: 0.004%
• All events occurred in patients in the BCP position.

Friedman, Orthopaedics, 2009

• And yet hypotension is common in the BCP position.


• So is hypotension the cause? Perhaps...

What is Hypotension?

- BP while asleep: drop $\approx 30\%$ from baseline

Soo et al, Anaesthesia, 2011
Blood Pressure – what is baseline?

Soo et al, Anaesthesia, 2011

MAP mmHg

- Pre-op baseline
- Daytime median -9.5%
- Sleep median -19.5%
- Sleep nadir -33.4%
- Intra-op nadir -35.2%

Soo et al, Anaesthesia, 2011
Siphon Model of CBF

\[ \text{Flow } \alpha A - V \]
Does a Siphon exist in upright humans?

![Graph showing MAP and IJVP](image)

**IJVP**=Internal Jugular Venous Pressure @ Base of skull

_Dawson et al, Standing up to the challenge of standing: a siphon does not support CBF in humans, ajpregu, 2004._
& in Giraffa camelopardalis...

Monitoring

NIRS

TCD

BP

?EEG

FIG. 1
Cerebral Oximetry (SctO2)

- Continuous wave technology: interpret photon scatter & absorption

- Frequency domain systems differentiate scatter & absorption.

*Davie et al, Anesthesiology, 2012*
NIRS in Sitting versus Lateral Position

Cerebral Desaturation Events (CDEs)

LDP = 0%

BCP = 80%

Murphy, A&A, 111(2), 2010
### SctO$_2$ & Upright position

<table>
<thead>
<tr>
<th></th>
<th>N=20</th>
<th>SctO2 Left</th>
<th>SctO2 Right</th>
<th>MAP @ Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awake</td>
<td></td>
<td>69</td>
<td>68</td>
<td>76</td>
</tr>
<tr>
<td>Supine</td>
<td></td>
<td>79</td>
<td>79</td>
<td>67</td>
</tr>
<tr>
<td>Upright Min Value</td>
<td>57*</td>
<td>59*</td>
<td>~30</td>
<td></td>
</tr>
</tbody>
</table>

- * p < 0.05 compared to awake & compared to supine asleep
- Decrease of >20% in SctO$_2$ in >80% patients.
- Decreases in SctO$_2$ correlated with BP drops (R = 0.6) & EtCO$_2$ (R = 0.47)

*Moerman et al, Eur J Anaesthesiology, 2012*
Influence of BP on Cerebral Perfusion & Oxygenation

**A**

Cortical oxygenation; change from baseline (%)

-60 -40 -20 0 20 40 60

Change in MAP (mmHg)

Mean slope = -0.18
\[ r = -0.78; \ P < 0.01 \]
\[ R^2 = 0.60 \]

**B**

Cerebral blood flow velocity; change from baseline (cm/s)

-60 -40 -20 0 20 40 60

Change in MAP (mmHg)

Mean slope = 0.55
\[ r = 0.88; \ P < 0.01 \]
\[ R^2 = 0.77 \]

Lucas, Blood Pressure & Cerebral Autoregulation, Hypertension, 2010
SctO2 with phenylephrine & head up position?

<table>
<thead>
<tr>
<th>N=34 RCT</th>
<th>Saline</th>
<th>Phenylephrine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SCO2%</td>
<td>MAP</td>
</tr>
<tr>
<td>Rm Air</td>
<td>68</td>
<td>94</td>
</tr>
<tr>
<td>Pre-O2</td>
<td>74</td>
<td>94</td>
</tr>
<tr>
<td>Post Induction</td>
<td>79</td>
<td>68</td>
</tr>
<tr>
<td>Post Infusion</td>
<td>76</td>
<td>71</td>
</tr>
<tr>
<td>Upright Position</td>
<td>68</td>
<td>53</td>
</tr>
</tbody>
</table>

*MAP: transducer @ level of head*  
*Soeding et al, BJA 2013*
SctO₂ & SjVO₂

Brassard, BJA, 2009
Cerebral Oximetry & SjvO2%

Jeong et al, Anesthesiology, 2012
NIRS & Extracranial Contamination

% change from baseline of StcO2

Davie & Grocott, Anesthesiology, 2012
Theoretical explanation for SctO2 changes seen with phenylephrine.

Baseline: A:V = 30:70

Vasoconstrictors: A:V < 30:70

Modified from Meng & Gelb, BJA, 2012
Transcranial Doppler (TCD)

Hypercapnia used to validate TCD against Xenon.

Correlation: $R = 0.849$

TCD & Hypotension with Beach Chair Positioning

Possible mechanisms for reduced MCAv:
1. Impaired autoregulatory response
2. Cerebral arterial pressure may have been below lower limit of autoregulation – MAP @ head <50mmHg in 11 of 19 patients.

McCulloch et al, AAIC, 2010
Components of Autoregulatory response

McCulloch et al, AAIC, 2010
Influence of BP on MCAv

Lucas, Blood Pressure & Cerebral Autoregulation, Hypertension, 2010
The impact of Cardiac Output on MCAv?

Ogoh, et al., J Physiol, 2005
Management Suggestions

[Comic panels showing a cartoon version of The Thinker sculpture, with a waiter and a customer, the customer saying, "Oh for God's sake, will you just order something!" and the waiter looking frustrated.]
Avoid Sitting Position

• US Survey of Shoulder Surgeons

• Low rate of stroke reported
  – rate in the beach chair position 0.00382% - 0.00461%

• *But*..

• All cerebrovascular events were associated with surgeries in the beach chair position.

*Friedman, Orthopedics, 2009, 32(4)*
Avoid GA?

Koh & Murphy et al, J Shoulder Elbow Surg, 2013
Maintain a Normal BP

- Awake
- Supine with 20% BP drop @ level of heart
- Beach Chair with 20% BP drop
Maintain or augment Cardiac Output

Supine patients, controlled ventilation, propofol/remi.

Meng, BJA, 2011
Schematic view of cervical spine and transcervical vessels, showing their relationships as the face is turned to the left. (1) Compression of carotid artery by transverse process of atlas, as postulated by Boldrey; (2) distortion of the vertebral artery as it lies upon the atlas; (3) osteophytic compression of vertebral arteries; (4) frequent site of atherosclerotic plaques in the carotid artery.

Toole J, Arch Neurol, 1960
Volatile vs Propofol?

Jeong et al., 2012

Graph showing changes in SjvO2 (%) and ScvO2 (%) over time after sitting position change, comparing S/N (n=19) and P/R (n=17) groups.
Other Monitors: Cerebral Oximetry or TCD?

• Interpret Cerebral Oximetry with caution.
• Future studies may provide clinical outcome data.
• TCD probably more robust but less convenient and unlikely to become a standard monitor.
Summary

• Incidence of stroke in BCP: seems to be low.
• Mechanism is likely to be hypoperfusion in these cases.
• Cerebral Oximetry as monitor of cerebral oxygenation in BCP is problematical, particularly following vasopressor use.
• TCD is a more robust but less convenient monitor of CBF
• BP measurement or calculation at level of head should be standard of care (there is no siphon)
• Maintenance of pre-op BP is probably reasonable approach.
• Consider augmenting CO rather than simply BP support.
• Consider use of regional & sedation rather than GA.
• Maintain neutral head position.
• If GA used aim for mild hypercapnia & perhaps use volatile rather than propofol based GA.
“Discouraging data on the anti-depressant”