Revista Mexicana de Anestesiología

CONFERENCIAS MAGISTRALES
Vol. 35. Supl. 1 Abril-Junio 2012
pp S364-S371

The sitting position: is it safe?

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DISCLOSURE INFORMATION

- I have the following financial relationship to disclose: Consultant for: CASMED, Inc.
- I will not discuss off-label use and/or investigational use in my presentation

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NEWSLETTER

The Official Journal of the Anesthesia Patient Safety Foundation

Volume 22, No. 2, 25-40 Circulation 61,499 Summer 2007

Beach Chair Position May Decrease Cerebral Perfusion

Catastrophic Outcomes Have Occurred

Case Presentation

Considerations When Using the Beach Chair Position

Are patients undergoing surgery in the sitting or beach chair position (BCP) at increased risk of adverse neurologic events in the postoperative period?

OVERVIEW

- What is the incidence of postoperative neurologic deficits following BCP surgery?
- What is the etiology of adverse neurologic events after surgery in the sitting position?
- Is there clinical data supporting (or questioning) the safety of sitting surgery?
- What can we do to potentially reduce the risk of adverse neurologic events in our BCP patients?

INCIDENCE

Case reports:

- Pohl and Cullen → 4 cases of ischemic brain and spinal cord injury (J Clin Anesth 2005;17:463-9.)
- Bhatti and Enneking → Visual loss and ophthalmoplegia after shoulder surgery (Anesth Analg 2003;96:899-902.)
- Drummond, et al. → hemiparesis in 50 year old man (Anesth Analg-in press)

Survey study

- Survey sent to 287 members of the ASES Society to assess incidence of CVA after shoulder surgery
- 93 surgeons responded
- 8 cerebrovascular events reported (all in BCP) (Friedman DJ, et al. Orthopedics 2009;32:256-240.)

Personal communications

- David Cullen → 11 additional cases in which patients suffered severe brain damage (APSF Newsletter 2010)
- Jeffery S. Vender → 5 cases of brain injury after shoulder surgery in the BCP
- Glenn Murphy → 3 cases in the Chicago area of CVA after sitting shoulder surgery
- APSF 2011 BOD Meeting → 17% of audience observed postoperative cognitive dysfunction following anesthesia in the BCP (Winter APSF Newsletter)
- Rare event → National Registry
- Similar to ASA postoperative visual loss registry

BLOOD PRESSURE MANAGEMENT IN THE BEACH CHAIR POSITION: NATIONAL SURVEY RESULTS

Lee LA, et al. ASA 2010; Annual meeting.

- 24 question survey distributed by APSF. Newsletter and website (*www.apsf.org*)

Results

- 104 completed surveys returned over 3 months
- Position: BCP (65%); lateral (12%); both (21%)
- Deliberate hypotension used by 28% of respondents; > 70% of this group used BCP
- BP goal: 10% baseline 26%; 30% baseline 9%
  20% baseline 49% SBP > 100 Hg 5%
- Arterial line use 14%
- BP correction for height 48%
- *# cases of severe brain damage reported: 12 (12% of institutions)*

ETIOLOGY/MECHANISMS OF CEREBRAL ISCHEMIA IN THE BCP

Air embolus

- 7 cases of VAE reported when CO_2 used as joint distending agent → 1 case brain stem ischemia (Anaethesia 2005;60:501-4.)

Cerebral intraluminal arthrosclerosis

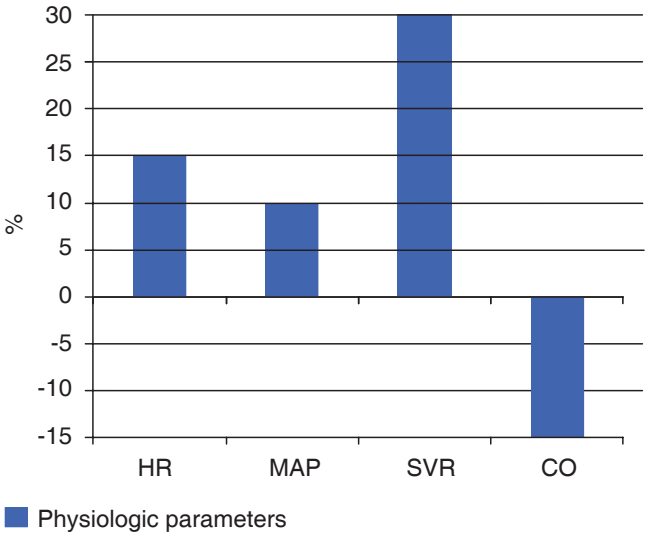
Absence of an intact or «classic» circle of Willis

- In a MR angiography study of 150 healthy volunteers, only 42% had an entirely complete circle of Willis (Radiology 1998;207:103-111.)

Deviations from classic vessel configuration in the neck

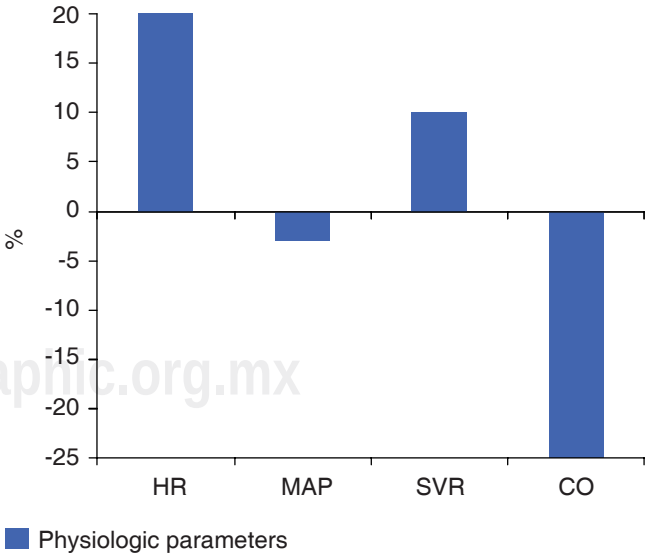
- In a study of 168 volunteers, congenital variations in the vertebral arteries were noted in 42 subjects (Wang Y, et al. J Ultrasound Med 2009;28:1481-6.)
- Compression/obstruction of venous or arterial vessels during head flexion/extension/rotation
- Decreases in cardiac output due to the effects of general anesthesia in the sitting position
- Decreases in systemic blood pressure due to the effects of general anesthesia in the sitting position → inadequate CPP

PHYSIOLOGIC EFFECTS OF THE SITTING POSITION: AWAKE SUBJECTS



Smith JJ, et al. J Clin Pharmacol 1994;34:375-86.

PHYSIOLOGIC EFFECTS OF THE SITTING POSITION: SUBJECTS UNDER GA



Porter JM, et al. Br J Anesth 1999;82:117-28.

HYPOTENSION IN THE SITTING POSITION

Year	Author	#	Def ↓ BP	Incidence(%)
1976[1]	Albin	180	> 10% ↓ MAP	32%
1985[2]	Matjasko	554	20% ↓ SAP	5%
1986[3]	Young	225	> 10 mmHg ↓ MAP	12%
1988[4]	Black	333	> 20% ↓ SAP	19%

1. Acta Anaesth Scand 20:117-28. 2. Neurosurg 17:695-702. 3. Neurosurg 18:157-61. 4. Anesthesiology 37:996-9.

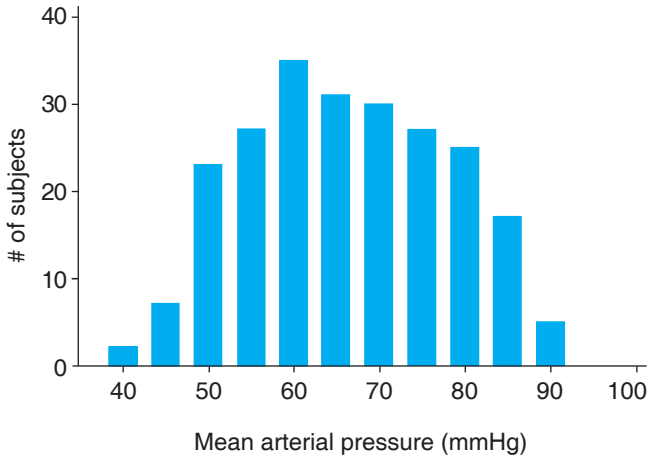
CURRENT DEBATE: HOW SHOULD BLOOD PRESSURE BE MANAGED DURING BCP SURGERY?

- What is the lower limit of acceptable blood pressure during anesthesia?
- Should blood pressure be corrected for the difference in height between the site of measurement and the brain?

SHOULD BLOOD PRESSURE BE CORRECTED? SIPHON CONCEPT

- Also called «closed model»
- Depends on the presence of a continuous column of blood in the arterial and venous limbs of the loop (aorta → brain → SVC)
- Gravitational effects are identical on the ascending and descending limbs of the vascular loop
- No correction is needed blood pressure measurements in the brain *vs* that in the arm because the afferent and efferent effects of gravity cancel each other out
- Head elevation leads to equivalent changes in arterial and venous pressure → no net change in CPP or CBF

Kirby and Cullen. APSF Newsletter Spring; 2009.



Joshi B, et al. Anesth Analg 2012;114:503-10.

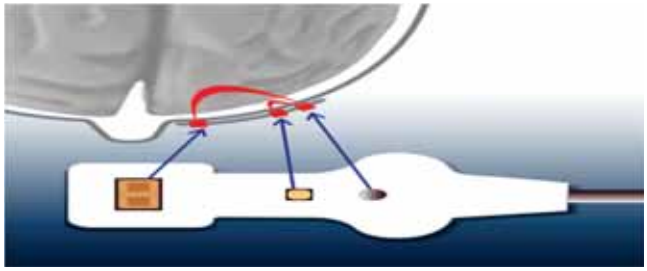
Author	Hipotensive technique	CBF Method	LLA mean (range)
McCall*[4]	Hydralazine	K-S/N2O	< 64 (33-80)
	Veratrum viride	K-S/N2O	< 57 (40-72)
Moyer, et al[6]	Hexamethonium	K-S/N2O	> 62 (53-80)
	Trimethaphan	K-S/N2O	> 57 (44-75)
	Pendiomide	K-S/N2O	< 61 (54-72)
Strandgaard[8]	Trimethaphan/tilt	1/A-VDO2	73 ± 9
Waldemar, et al[10]	Trimethaphan/ lower body negative pressure ± captopril	1/A-VDO2	79 (57-101)
Larsen, et al[11]	Lower body negative pressure/labetalol	1/A-VDO2	79 (53-113)
		CBFVmca	91 (41-108)
Olsen, et al[12]	Labetalol/lower body negative pressure	1/A-VDO2	88 (76-101)
Olsen, et al[13]	Lower body negative pressure/labetalol	1/A-VDO2	73 (60-100)
		A-NIRS diff	79 (73-101)

Drummond JC. Anesthesiology 1997;86:1431-3.

SHOULD BLOOD PRESSURE BE CORRECTED? WATERFALL CONCEPT

- Also called «open model»
- Collapsible veins prevent gravitational pressure gradients from being matched on the arterial and venous sides of the vascular loop → preventing the siphon effect from operating
- Blood «falls» in the descending limb and does not aid the ascending limb
- Heart is solely responsible for pumping blood to the brain → pressure gradient exist from the heart to the brain →↓ arterial pressure related to weight of a column of blood (1 mmHg for each 1.35 cm height difference)
- If MAP at arm 80 mmHg → 38 cm vertical distance to frontal lobes → «corrected» MAP at brain 51.8 mmHg

CLINICAL STUDIES-SAFETY BCP



- Most studies have used cerebral oximetry (NIRS) to assess evidence of inadequate oxygen supply to brain
- Measure regional tissue oxygenation ($SctO_2$) in area of brain vulnerable to changes in oxygen supply / demand (frontal cortex-watershed area)
- Represents primarily venous (75-85%) *vs* arterial (15-25%) blood
- Critical threshold: decreases in $SctO_2$ of 15-25%
  - **Symptoms cerebral ischemia in awake patients undergoing CEA**
  - **20X increased risk of developing cerebral ischemia on EEG (CEA)**
  - **Cognitive dysfunction /organ dysfunction after cardiac surgery**
  - **Longer hospital LOS after abdominal surgery**

REGIONAL CEREBRAL OXYGEN SATURATION AND EEG CHANGES CAUSED BY BEACH CHAIR POSITION

Abstract: Fujiwara Y, et al. ASA Annual Meeting 2008.

	Before BCP	After BCP
SBP (mmHg)	95 ± 13	73 ± 15
DBP (mmHg)	44 ± 7	33 ± 11
HR (bpm)	59 ± 8	56 ± 4
$SctO_2$ (%)	72 ± 11	57 ± 12
SMF (Hz)	5.8 ± 2.0	4.4 ± 1.3
SEF95 (Hz)	12.3 ± 1.8	11.2 ± 1.8

All changes were statistically significant

ABSOLUTE CEREBRAL OXIMETRY IN BENCHCHAIR POSITIONING FOR SHOULDER SURGERY

Lathouwers KM, et al. Abstract ASA Annual Meeting 2009.

- Data collected on 90 patients undergoing shoulder surgery in the BCP (n = 45) or LDP (n = 45)
- GA used in all patients
- $SctO_2$ assessed in all subjects

Results

- BCP resulted in immediate 16.9% decrease in $SctO_2$
  - No difference in MAP between BCP and LDP groups
  - CDE (defined as $SctO_2$ below 55%) occurred in 38 of 45 patients in the BCP group, and in 0 of 45 patients in the LDP group

EUROANESTHESIA 2009

TITLE: MONITORING OF ABSOLUTE CEREBRAL OXYGEN SATURATION (FORE-SIGHT TECHNOLOGY) DURING ENDOSCOPIC SHOULDER SURGERY: BENCHCHAIR POSITIONING COMPARED TO CONVENTIONAL POSITIONING

Roy Somers, Cathy De Deyne, Frank Jans, Jan Oosterbosch and René Heylen. Department of Anesthesia & Orthopedic Surgery, Ziekenhuis Oost-Limburg, Genk Belgium.

- $SctO_2$ data collected on 28 patients undergoing endoscopic shoulder surgery in the BCP (n = 14) or LDP (n = 14)

Results

  - Mean $SctO_2$ values were similar between groups at baseline (73%)
  - Positioning in BCP resulted in 17.2% decrease in $SctO_2$ values
  - Despite MAP values of 80-90 mmHg in BCP group, ↓ in $SctO_2$ > 25% were observed in 12 of 14 patients
  - No critical drops in $SctO_2$ were observed in LDP group

BEACH CHAIR POSITIONING RESULTS IN SIGNIFICANTLY LOWER CEREBRAL OXYGEN SATURATION

De Burghgraeve F, et al. ASA Annual Meeting 2010 (A1686).

- $SctO_2$ data collected on 180 patients undergoing shoulder surgery in the BCP (n = 90) or LDP (n = 90)
- All received propofol/remifentenyl GA with block

	LDP	BCP
Mean SBP	86 mmHg	85 mmHg
Baseline $SctO_2$	80%	77%
Positional $SctO_2$	73%	61%
Lowest $SctO_2$	66%	54%
$SctO_2$ < 55%	5/90	55/90

CEREBRAL OXIMETRY IN PATIENTS UNDERGOING SHOULDER ARTHROSCOPY IN THE SITTING POSITION

Liu SS, et al. ASA Annual Meeting 2010 (A959)

- Examined association of BP management to SctO2 and stroke
- 61 patients received regional anesthesia and sedation

Results

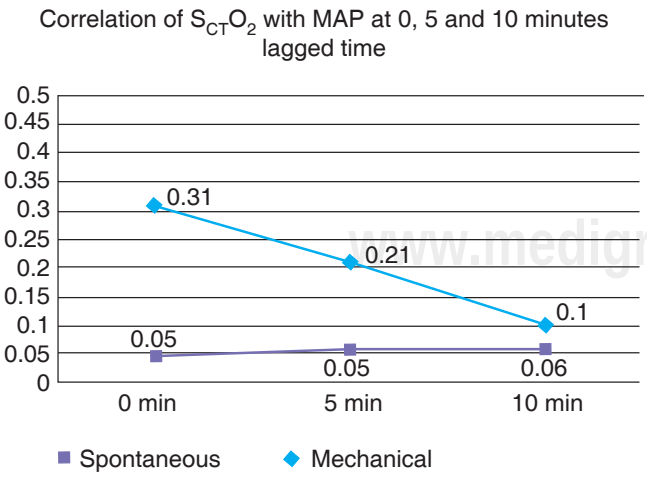
  - Baseline SBP 134 mmHg baseline MAP 99 mmHg
  - 31% had at least 30% decrease in MAP
  - 20% had MAP < 66 mmHg
  - 15% had a SBP < 90 mmHg
    - *$SctO_2$ decreases of > 20% from baseline (or < 50%) were observed in only 2% of patients*
  - No strokes were observed
  - Minimal correlations between SBP/MAP and $SctO_2$ noted

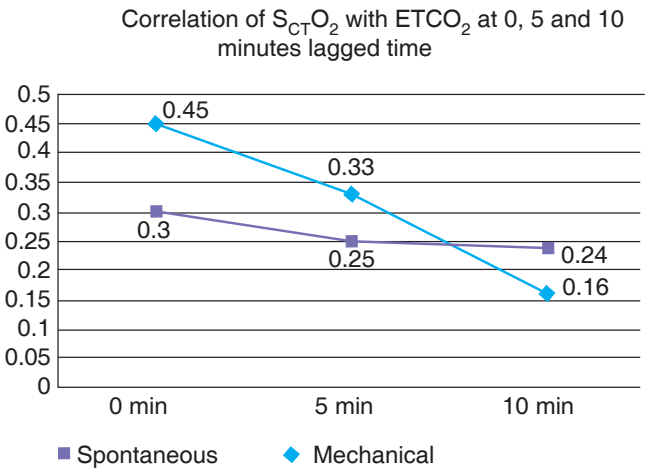
THE EFFECT OF ANESTHETIC TECHNIQUE ON CEREBRAL OXYGENATION IN THE BEACH CHAIR POSITION

Weiner MM, et al. ASA Annual Meeting 2010 (A1532)

- Investigated relationship between rSO_2 and MAP/$ETCO_2$
  - 3 groups of patients
    - ISB with propofol sedation (n = 44) SV
    - ISB with LMA (sevoflurane) (n = 30) SV
    - ISB with OETT (isoflurane) (n = 7) MV

CEREBRAL OXYGEN DESATURATION EVENTS

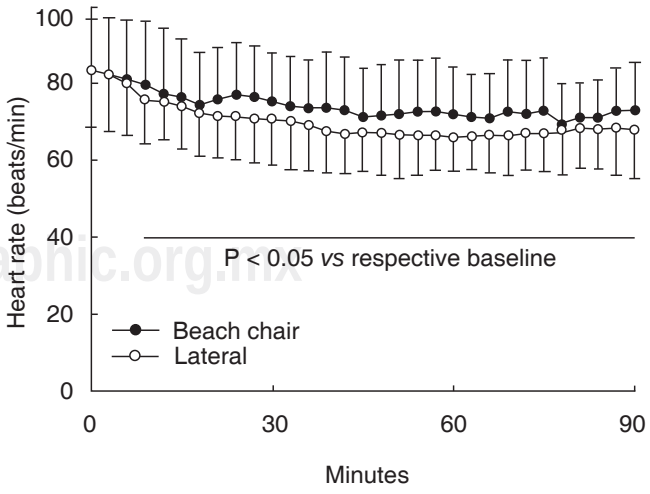


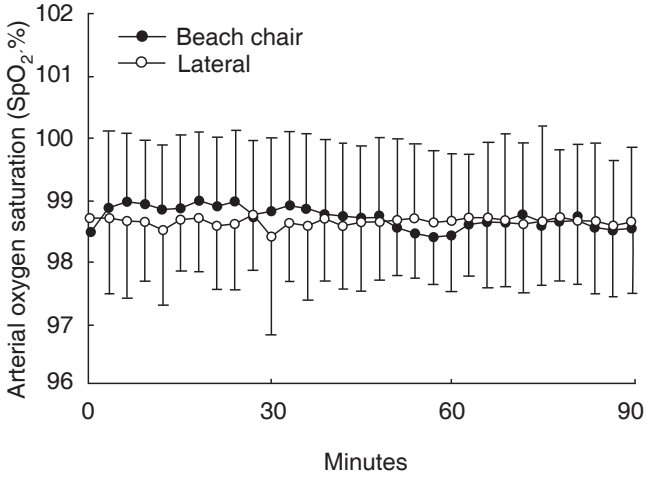


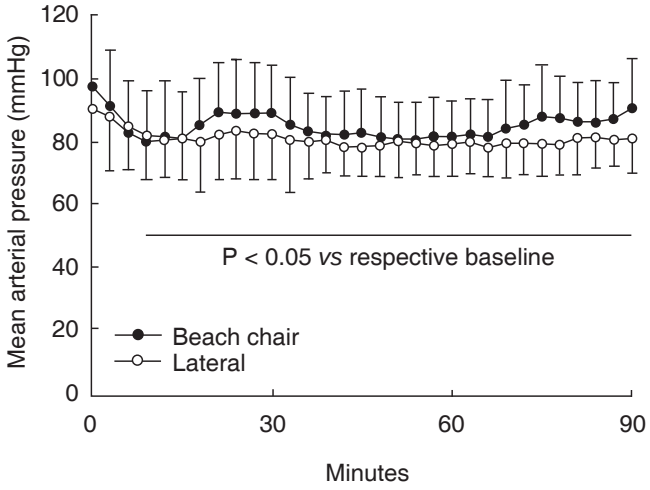
ASSESSED BY NEAR-INFRARED SPECTROSCOPY DURING SHOULDER ARTHROSCOPY IN THE BEACH CHAIR AND LATERAL DECUBITUS POSITIONS

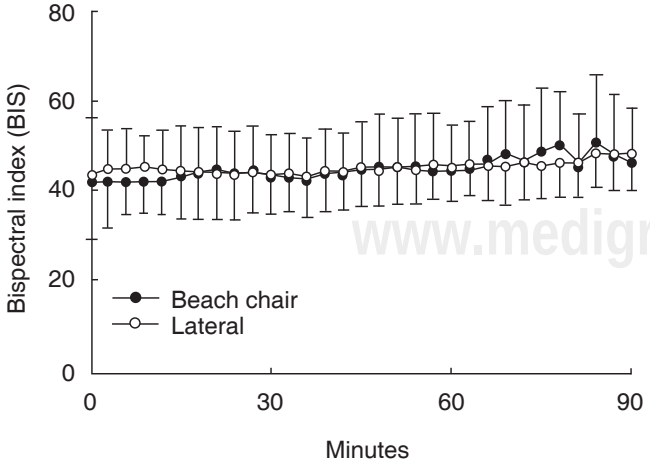
Murphy GS, et al. Anesth Analg 2010;111:496-505.

- Data collected on 124 patients undergoing shoulder surgery in the BCP (n = 61) or LDP (n = 63)
- All patients received a standardized GA
- MAP maintained within 20% of baseline values in all subjects
- $SctO_2$ measured in all subjects
- CDE defined as a 20% drop in $SctO_2$ or a decrease in $SctO_2$ below 55%
- CDE treated according to a standardized protocol
- Postoperative recovery variables assessed to determine association between CDE → impaired clinical recovery



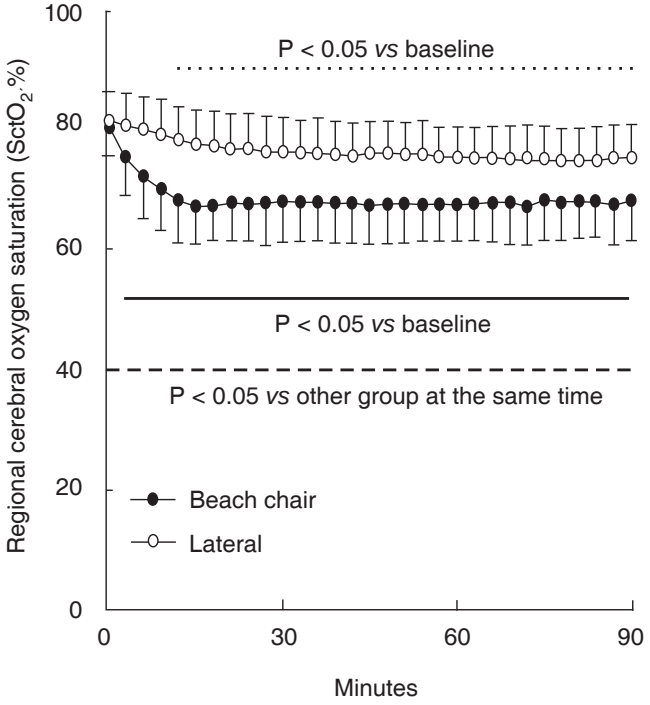






CEREBRAL OXYGENATION: MURPHY, ET AL.

- CDE observed in 80.3% of patients in the BCP group *vs* 0% in the LDP group ($p < 0.0001$)
- Median number of CDE was higher in BCP group (4) than the LDP group (0, $p < 0.003$), as was the median number of interventions to treat CDE ($p < 0.0001$)



CLINICAL RECOVERY: MURPHY, ET AL.

- Patients with CDE were compared to those without CDE
- No difference between CDE group and no CDE group in early recovery landmarks (open eyes, squeeze hand, tracheal extubation, PACU arrival)
- No difference between CDE group and no CDE group in Aldrete scores in PACU
- No difference between CDE group and no CDE group in PACU LOS

	CDE Group	No CDE group
Nausea	50.0%	6.7% (p = 0.0001)
Vomiting	27.3%	3.3% (p = 0.011)

CEREBRAL DESATURATION EVENTS DURING SHOULDER SURGERY IN THE BEACH CHAIR POSITION: GENERAL *VERSUS* REGIONAL ANESTHESIA

Table III. Cerebral desaturation events and treatments.

	GA group	ISB group	Difference or median difference (99% CI)	P value
Number	30	30	–	–
Episodes ≥ 20% decrease $SctO_2$				
Patients (%)	17 (56.7%)	0 (0%)	56.7% (34.2 to 76.7%)	< 0.0001
Episodes in individuals	1 (0-20)	0 (0-0)	1 (0 to 2)	< 0.0001
Episodes in group	72	0	–	–
Episodes SctO2 ≤ 55%				
Patients (%)	7 (23.3%)	1 (3.3%)	20.0% (-3.6 to 44.5%)	0.052
Episodes in individuals	0 (0-6)	0 (0-1)	0 (0 to 0)	0.028
Episodes in group	18	1	–	–
Interventions for $SctO_2$ drops				
Patients (%)	13 (43.3%)	0 (0%)	43.3% (21.5 to 65.8%)	< 0.0001
Interventions in individuals	0 (0-8)	0 (0-0)	0 (0 to 2)	< 0.0001
Interventions in group	38	0	–	–
Interventions for MAP drops				
Patients (%)	22 (73.3%)	3 (10.0%)	63.3% (32.5 to 82.2%)	< 0.0001
Interventions in individuals	2 (0-20)	0 (0-7)	2 (1 to 6)	< 0.0001
Interventions in group	131	9	–	–
Phenylephrine dose (micrograms)	400 (0-1,840)	0 (0-560)	320 (320 to 800)	< 0.0001

Murphy GS, et al. Submitted for publication

CEREBRAL OXYGEN SATURATION MEASURED BY NEAR-INFRARED SPECTROSCOPY AND JUGULAR VENOUS BULB OXYGEN SATURATION DURING ARTHROSCOPIC SHOULDER SURGERY IN BEACH CHAIR POSITION UNDER SEVOFLURANE-NITROUS OXIDE OR PROPOFOL-REMIFENTANYL ANESTHESIA

- 40 patients randomized to receive either sevo-nitrous or propofol-remifentanyl during BCP shoulder surgery
- $SjvO_2$, $SctO_2$, and hemodynamics measured in all patients

Results

- MAP decreased in both groups (P/R more than S/N)
- $SjvO_2$ decreased significantly both groups [P/R (23%) more than S/N (11%)]
- Incidences of CDE did not differ between groups
- $SjvO_2$ and $SctO_2$ only weakly correlated

Jeong H, et al. Anesthesiology 2012;116:1047-56.

WHAT CAN WE DO TO POTENTIALLY REDUCE THE RISK OF ADVERSE NEUROLOGIC EVENTS FOLLOWING SURGERY IN THE SITTING POSITION?


apsf NEWSLETTER
The Official Journal of the Anesthesia Patient Safety Foundation
www.apsf.org
Volume 24, No. 4, 45-68 Circulation 84,122 Winter 2009-2010
APSF Workshop: Cerebral Perfusion Experts Share Views on Management of Head-Up Cases

APSF BOD WORKSHOP RECOMMENDATIONS

Group 1: What further research needs to be done?

- APSF conduct a poll to determine the range of anesthetic practice for shoulder surgery in the BCP
- Establish a national database to identify association b e - tween surgery in the BCP → adverse neurologic outcomes
- Fund prospective studies using sensitive markers of cerebral ischemia (neurocognitive testing)
- Fund prospective studies examining how intraoperative factors may influence outcomes after BCP surgery (fluid administration, ventilation, head position)

Group 2: What can companies do to make a difference?

- Develop accurate continuous non-invasive BP monitoring
- Use «smart alarm» to warn clinicians when critical thresholds have been exceeded
- Standardizing the degree of incline used during these procedures
- User-friendly, non-invasive cerebral function monitors
- Educate surgeons about risks of BCP surgery

Group 3: What are the current best practices for BP management?

- No generally accepted method of defining baseline BP
- No non-invasive method of defining LLA for any given patient
- BP in the BCP should be adjusted to account for a hydrostatic gradient
- Deliberate hypotension should be avoided in the BCP
- Maximum reduction in BP from baseline should be 30% after accounting for hydrostatic gradient in BCP
- No consensus on best method to raise BP
- Non-invasive BP should be taken in arm, not leg

Group 4: What should the APSF recommend as the next best steps?

- Increased awareness of the presence of a hydrostatic gradient between BP measurement site in the arm and BP in the brain
- Increased awareness of importance of maintaining BP near baseline values
- Importance of maintaining head in neutral position
- APSF contact surgical journals about risks of deliberate hypotension in BCP
- Increased focus on informed consent and shared responsibility with the surgeon

THE RISKS OF SITTING POSITION SURGERY: CONCLUSIONS

- The incidence of major adverse neurologic events after surgery in the BCP is rare, but is likely under-reported
- The etiology of these events is uncertain, but is likely related to cerebral hypoperfusion due to reductions in CBF or CPP
- Clinical studies with cerebral oximetry/EEG suggest that cerebral ischemia is not a rare event in the BCP
- Deliberate hypotension should be avoided in the BCP
- MAP should be maintained at baseline values → within 30% baseline values after accounting for hydrostatic gradient
- Further studies are urgently needed to assess the incidence, mechanisms, and safety of surgery in the BCP