THE EFFECT OF HEAD POSITION ON CEREBRAL AUTOREGULATION IN ACUTE ISCHAEMIC STROKE

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Background

Acute ischaemic stroke (AIS) patients are routinely nursed with head elevation ($\geq 30^\circ$), however, little is known on how cerebral autoregulation (CA), and associated haemodynamic parameters, respond to gradual transition in head positioning.

Aim

To assess beat-to-beat changes in cerebral blood flow velocity (CBFv), and other cerebral haemodynamic parameters, including autoregulation index (ARI) in healthy controls (HC) and AIS during transition from a ‘lying flat’ (FLAT) (0°) to ‘sitting up’ (SIT) ($\geq 30^\circ$) head position.

Methods

- HC and AIS underwent supine recording on a bed, with the recumbent angle measured by an electronic goniometer (Figure 1).
- Simultaneous bilateral middle cerebral artery CBFv, beat-to-beat blood pressure (BP), electrocardiography and end tidal CO_2 were measured in FLAT (0°) and SIT (30°) head position.
- 5 minutes recording in each head position with 30 second transition (Figure 2).
- Mean values of physiological parameters and ARI (Transfer function analysis and Tiecks’ model) were calculated.

Figure 2: Transition of head position changes

Figure 1: PHYSIDAS screenshot, TRANS channel (bottom right) showing how electronic goniometer measuring the head position changes during assessment

Results & Discussion

- 16 HC (8 female, age 57 ± 17 years) and 15 AIS (8 female, age 70 ± 8 years) participants, were assessed at two (12 ± 8 days) and three visits (13.3 ± 6.9 hrs, 4.8 ± 3.2 days and 93.9 ± 11.5 days of stroke symptom onset), respectively.
- Repeated measure ANOVA showed there was no significant difference between HC at Visit 1 and 2, these values were averaged subsequently for comparison with AIS (Table).
- AIS were significantly more hypertensive than HC at Visit 1 ($p < 0.017$).
- Baseline ETCO_2 was significantly lower in AIS patients at all 3 visits ($p < 0.017$).
- Baseline CBFv was significantly lower in the affected hemisphere (AH) of AIS patients compared to dominant hemisphere (DH) of HC at Visits 1 and 3 ($p < 0.017$).
- In the sitting position (30°), BP reduction was observed in HC and AIS participants at all visits ($p < 0.001$ and $p = 0.005$, respectively).
- In the sitting position (30°), there was significant reduction in ARI index in AH AIS at Visits 2 and 3, and non-AH (NAH) at Visit 1, when compared to lying flat (0°) head position.

Parameters	HC Average of Visits 1 and 2 (n=16)		HC P value (Head Position)	HC P Value (Visit)	AIS Visit 1 (n=15)		AIS Visit 2 (n=12)		AIS visit 3 (n=13)		AIS P value (Head Position)	AIS P value (Visit)
	5-min FLAT (0°)	5-min SIT (30°)			5-min FLAT (0°)	5-min SIT (30°)	5-min FLAT (0°)	5-min SIT (30°)	5-min FLAT (0°)	5-min SIT (30°)		
Mean Arterial BP (mmHg)	89.5 $\pm$ 11.6	80.9 $\pm$ 9.0	<0.001	0.39	101.0 $\pm$ 17.0 *	90.8 $\pm$ 7.4 *	93.8 $\pm$ 11.6	86.8 $\pm$ 11.2	95.3 $\pm$ 11.0	94.8 $\pm$ 11.1 *	0.005	0.42
Heart Rate (bpm)	65.5 $\pm$ 10.5	65.1 $\pm$ 10.2	0.42	0.89	68.4 $\pm$ 15.0	67.8 $\pm$ 14.7	62.8 $\pm$ 14.3	62.7 $\pm$ 15.6	65.2 $\pm$ 15.8	64.8 $\pm$ 15.4	0.29	0.83
End-tidal CO_2 (mmHg)	38.9 $\pm$ 3.5	38.6 $\pm$ 2.7	0.39	0.38	33.5 $\pm$ 2.7 *	31.8 $\pm$ 4.1 *	31.8 $\pm$ 6.9 *	34.2 $\pm$ 2.5 *	33.6 $\pm$ 4.3 *	33.2 $\pm$ 5.7 *	0.50	0.99
CBFv (DH vs. AH) (cm.s^{-1})	52.7 $\pm$ 12.2	49.8 $\pm$ 13.3	0.001	0.92	38.3 $\pm$ 14.4 *	36.7 $\pm$ 14.5 *	44.8 $\pm$ 14.3	46.2 $\pm$ 14.9	38.1 $\pm$ 14.5 *	37.6 $\pm$ 12.1 *	0.80	0.37
CBFv (NDH vs. NAH) (cm.s^{-1})	52.6 $\pm$ 13.6	51.2 $\pm$ 13.6	0.05	0.45	43.4 $\pm$ 14.9	43.5 $\pm$ 15.0	41.4 $\pm$ 9.4	40.7 $\pm$ 10.1	41.1 $\pm$ 8.9 *	41.2 $\pm$ 5.7 *	0.75	0.62
ARI (DH vs. AH)	5.75 $\pm$ 1.53	5.62 $\pm$ 1.36	0.62	0.86	5.34 $\pm$ 2.11	4.33 $\pm$ 2.0	4.29 $\pm$ 1.12	3.85 $\pm$ 1.47 §	4.92 $\pm$ 1.56	4.04 $\pm$ 1.25 §	0.013	0.62
ARI (NDH vs. NAH)	5.91 $\pm$ 1.41	5.97 $\pm$ 1.16	0.37	0.88	5.55 $\pm$ 1.8	4.31 $\pm$ 1.96 §	4.38 $\pm$ 1.98	4.50 $\pm$ 1.98	5.64 $\pm$ 1.56	5.33 $\pm$ 1.60	0.22	0.12

Conclusion

Head positioning can have significant effects on both peripheral and cerebral haemodynamics in AIS. Importantly, there was a significant reduction in ARI when head position changed from FLAT (0°) to SIT (30°) in AIS at all 3 visits. Further investigation is needed to ensure appropriate head position for individualised care in AIS, aiming to optimise patient recovery and outcome.

Table: Peripheral and cerebral haemodynamic parameters, as mean $\pm$ SD for 5 min segments of data. P values from two-way ANOVA for the difference between 5-min FLAT (0°) and SIT (30°) head position, between visit 1 and 2 in HC and visit 1, 2, 3, in AIS.

ARI, autoregulation index; BP, blood pressure; bpm, beat per minute; CBFv, cerebral blood flow velocity; DH: dominant hemisphere; NDH: non-dominant hemisphere; AH: affected hemisphere; NAH: non-affected hemisphere.

* $p < 0.017$ Independent T test to compare HC and AIS, between different head position and visit.

§ $p < 0.017$ Mann Whitney test to compare HC and AIS, between different head position and visit.

References

- Tiecks, F. P., Lam, A M., Aaslid, R., & Newell, D. W. (1995). Comparison of static and dynamic cerebral autoregulation measurements. *Stroke; a Journal of Cerebral Circulation*, 26(6), 1014–1019.
- Olavarria, V. V., Arima, H., Anderson, C. S., et al. (2014). Head position and cerebral blood flow velocity in acute ischemic stroke: a systematic review and meta-analysis. *Cerebrovascular Disease*, 37(6), 401-408.