The Effect of Baseline Blood Pressure on Dynamic Cerebral Autoregulation in Adolescents

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Introduction

• Dynamic cerebral autoregulation refers to the maintenance of cerebral blood flow during transient changes in arterial pressure and is an important parameter of cerebral health.
• Using a repeated squat-stand challenge, Brassard et al., observed that cerebral blood flow is better maintained during transient hypertension than hypotension in healthy adults 1, shown through a smaller change in cerebral blood flow for a given change in blood pressure.
• Puberty is known to influence cerebral blood flow at rest 2 and appears to be regulated differently during exercise in children compared to adults 3, though whether this pattern in the cerebral pressure-flow relationship is present in the adolescent brain is yet to be determined.
• Manipulation of baseline blood pressure allows investigation to further understand the cerebral pressure-flow relationship.
• An incremental ramp test to exhaustion results in transient hypotension 4.

Purpose

The present study aimed to characterise dynamic cerebral autoregulation in adolescents and examine the effect of baseline blood pressure on the cerebral pressure-flow relationship.

Methods

• Sixteen participants completed the protocol, but data loss resulted in a final sample of ten adolescents (6 girls, 4 boys, mean ± SD age, height and weight of 14.3 ± 0.4 years; 166.9 ± 6.2 cm; 58.1 ± 7.0 kg, respectively)

Experimental Protocol (see Fig 1):

• Participants completed a 5 minute seated baseline before completing 5 minutes of repeated sit-stand manoeuvres at 0.05 Hz (10-s standing, 10-s seating)
• Participants then repeated the sit-stand challenge approximately 80 minutes after an incremental ramp test to exhaustion, which coincides with the period of hypotension observed post-exercise.

Experimental Measures

• Right middle cerebral artery blood flow velocity (MCAv) was measured using transcranial Doppler ultrasonography (DWL, Germany).
• Beat-by-beat blood pressure was measured at the finger and kept at chest height throughout the sit-stand protocol for measurement of mean arterial pressure (MAP) (Finapres, Netherlands).
• Data were collated using an analogue to digital converter (PowerLab, UK).

Results

Cerebral Autoregulation at Rest

• %ΔMCAv/%ΔMAP was not different between hypertension and hypotension at rest (1.46 ± 0.65 and 1.66 ± 0.79 %/% respectively, P=0.56, Fig 2.A).

Influence of Incremental Exercise

• Baseline MCAv was significantly lowered following the ramp test (80.6 ±13.4 vs 74.9 ±12.3 cm/s, P=0.015), but MAP was not significantly altered (93.0 ±6.7 vs 87.8 ±5.5 mmHg, P=0.110).
• %ΔMCAv/%ΔMAP was not different between standing and sitting following the ramp test (1.41 ± 0.61 and 1.73 ± 0.76 %/% respectively, P=0.35, Fig 2.B).
• %ΔMCAv/%ΔMAP following the ramp test was not significantly different to baseline for either sitting (P=0.81) or standing (P=0.87).

Data Analyses

• Cerebral autoregulation was calculated using the methods of Brassard et al. 1  
  • The percentage change in MCAv per percent change in MAP (%ΔMCAv/%ΔMAP) was averaged separately for transient hypertension (stand) and hypotension (sit).
• Following removal of negative values and values >2SD from the mean, %ΔMCAv/%ΔMAP were averaged for all sits and stands.
• Paired t-tests compared %ΔMCAv/%ΔMAP values before and after the ramp, as well as comparing %ΔMCAv/%ΔMAP between hypertension and hypotension at each time point.
• The relationship between the change in resting MAP and MCAv and the change in %ΔMCAv/%ΔMAP during hypertension and hypotension was examined with Pearson’s correlation coefficient.

Conclusions

• The present data suggest the adolescent brain is similarly able to regulate cerebral blood flow in response to transient hypertension and hypotension, contrary to adult data 1. This suggests that regulation of cerebral blood flow differs with age and maturation, though requires further investigation.
• These findings indicate that changes in both baseline blood pressure and cerebral blood flow following exhaustive exercise influence the cerebral pressure-flow relationship in adolescents, and presents a novel area for further investigation.

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