Visual neurovascular coupling altered in a subgroup of formerly pre-eclamptic women

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E.G.H.J. Martens[1,3], E.D. Gommer[1,3], L.L.H. Peeters[2], F.N. v.d. Vosse[3], W.H. Mess[1], J.P.H. Reulen[1]

Departments of Clinical Neurophysiology [1] Gynecology and Obstetrics [2], University Hospital Maastricht
Department of Biomedical Engineering [3], Eindhoven University of Technology

Introduction

Neurovascular Coupling (NVC) controls cerebral blood flow to metabolic need, for example a visual stimulus results in a higher metabolic need and thus demands an increased blood flow to and in the visual cortex. Since pre-eclamptic women may experience abnormal visual symptoms such as light flashes, we investigated NVC of formerly pre-eclamptic patients by visual stimulation.

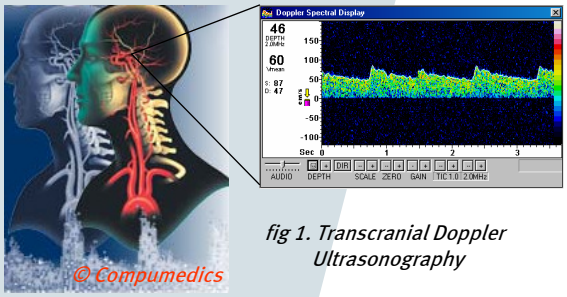

fig 1. Transcranial Doppler Ultrasonography

Blood flow velocity to the visual cortex is measured by Transcranial Doppler Ultrasonography (TCD, fig. 1) of the posterior cerebral artery (PCA).

Our hypothesis is: NVC is reduced in formerly pre-eclamptic patients compared to matched controls

Patients and methods

Patients

The NVC has been evaluated in three groups:

- Formerly pre-eclamptic patient group (PE, n = 15)
- Formerly eclamptic patient group (E, n = 13)
- An age, BMI and post-pregnancy-period (0.5-6.0 yrs) matched control group (C, n = 13)

Methods

TCD blood flow velocity (CBFV) of the P2-segment of the left PCA was recorded during 10 minute cyclic visual stimulation (40s "on" [cartoon], 20s "off" [eyes closed]).
The 10 CBFV response cycles are averaged and "on"-PCA responses were expressed as a percentage of the mean of the last 10s of the "off"-PCA response.

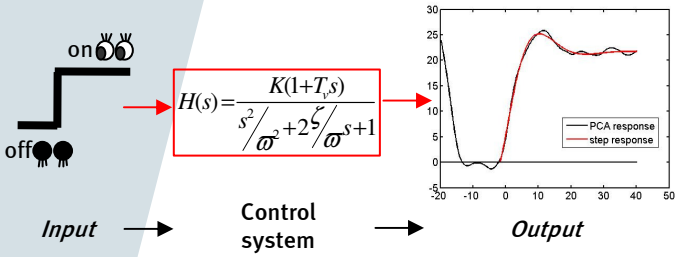

fig 2. The NVC system described as a 2nd order model with a step as input and a step response as output

The NVC control system can be described as 2nd order model with the visual stimulus as a step input and the PCA response as output. The response can be model fitted and quantified by its system parameters K (gain), ω (frequency), T_v (rate time) and ζ (damping), (fig. 2). Parameters T_v and ζ mainly describe the dynamic behaviour of the response.

Results

Quantitative results

Table I. Mean Parametervaluesper group

	PE (n=15)	E (n=13)	C (n=13)
K (%)	24 ± 9	24 ± 6	28 ± 7
ζ	0.8 ± 0.4	0.7 ± 0.3	0.6 ± 0.2
ω (1/s)	0.21 ± 0.08	0.25 ± 0.11	0.23 ± 0.08
T_v (s)	11.0 ± 16.7	5.8 ± 6.6	4.8 ± 7.8

Qualitative results

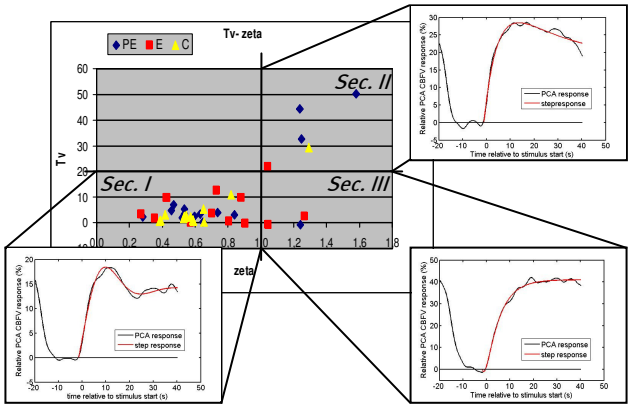

fig 3. Based on dynamic behaviour parameters T_v and ζ (zeta), 3 types of responses can be identified (Section I, II and III)

Discussion

Control parameters nicely match literature values. In 8 subjects (fig. 3 sec. II+III) damping ζ exceeds 1, suggesting a critically damped response. In 5 of them also T_v is enlarged. A large ζ (sec. III) may indicate greater stiffness of the cerebrovascular system. An additionally enlarged T_v (sec. II) means upregulation of the differentiator of the transfer function. This may be a compensation mechanism for damped responses to attain adequate blood flow.

Conclusions

NVC is altered in a subgroup of formerly (pre-)eclamptics. In some of them compensation seems to occur, but in others compensation fails. Further research is mandatory to explain this physiologically.