Failure of cerebral autoregulation as a cause of brain dysfunction in the elderly

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Summary and conclusions

Cerebral blood flow in relation to change in arterial pressure was measured in 11 elderly patients with postural hypotension. Seven patients with symptoms showed bilateral or unilateral failure of cerebral autoregulation, whereas in the four asymptomatic patients it did not. Variations in cerebral autoregulation would explain why some elderly people with minor falls of systemic arterial pressure develop clinical signs of cerebral ischaemia whereas others with greater falls in blood pressure remain asymptomatic.

Elderly patients with impaired autoregulation may be at risk of brain damage from minor falls in blood pressure.

Introduction

In normal subjects the cerebral circulation has a substantial capacity for autoregulation. When systemic arterial pressure falls cerebral vessels dilate so that cerebral blood flow is not reduced until mean arterial pressure falls below 60 mm Hg. Patients with postural hypotension had a fall in blood pressure of more than 20 mm Hg systolic and more than 10 mm Hg diastolic on standing from the horizontal position. Symptoms of cerebral ischaemia included giddiness, faintness, blackouts, and confusion states. None of the patients or controls received drugs which could affect the arterial blood pressure or cerebral blood flow. All subjects had a normal packed cell volume. Informed consent was obtained from all patients and their relatives.

Cerebral blood flow (CBF) was measured by the method of Mallett and Veall as modified by Obrist et al using inhalation of xenon-133, or by the method of Agnoli et al using intravenous injection. 5mCi of xenon-133 in 5 litres of air was used for the inhalation method and 3mCi of xenon-133 for the intravenous injection method; these doses were approved by the isotope advisory panel. Clearance curves were recorded using sodium iodide detectors, 5 cm in diameter and 3 mm thick with a parallel hole collimator and 2 cm of collimation centred over the temporal areas. Single-channel analysers were set out on the 80 keV photopeak of xenon with a window of 32 keV. Xenon-133 in expired air was measured with a third counter. The end-expiratory carbon dioxide level (in air) was recorded continuously by an infrared analyser (Capnograph).

The systemic arterial pressure was recorded automatically by a non-invasive technique using the Roche Arteriograph and a WW recorder. Systolic and diastolic blood pressures, checked at intervals by the aural auscultatory method, did not vary by more than 5 mm Hg from the automatic recorded results. The mean arterial blood pressure (MAPB) was calculated as the diastolic pressure plus one-third of the pulse pressure. Patients and controls were studied on a tilting bed in the horizontal and 75° feet-down positions.

Mean CBF of each hemisphere was calculated from the xenon-133 clearance curves by the initial log slope method. A difference of 10% in the same hemisphere was considered to be significant.

Results

Of the seven patients with postural hypotension and symptoms, four had bilateral failure of autoregulation: their mean CBF fell by 32-67%, and MAPB fell 9-33 mm Hg with change in posture (see table). The remaining three patients had a fall in MAPB of 8-12 mm Hg with change in posture. Mean CBF in one hemisphere fell 22-49% while in the other hemisphere there was no significant change.

In the four asymptomatic patients MAPB fell 10-31 mm Hg with change in posture; but there was no significant change in mean CBF, even in the patient whose MAPB fell to 54 mm Hg (see table).

The four controls showed normal blood pressure responses to a change in posture and no significant change in CBF.

Discussion

The elderly patients with postural hypotension and symptoms showed bilateral or unilateral failure of cerebral autoregulation which was not found in asymptomatic elderly patients.

The metabolic control of cerebral blood flow is mainly by arterial PCO₂ and pH, a fall in PCO₂ causing vasoconstriction and a rise in perfusion pressure. There is increasing evidence that sympathetic pathways from the brain to the cerebral blood vessels must be intact for normal autoregulation to occur. Failure of cerebral autoregulation has been described in some patients with autonomic dysfunction, but not in others. Impaired autonomic function is common in the elderly, and blocked autonomic reflexes might therefore be the cause of both postural hypotension and failure of cerebral autoregulation in some elderly patients.

Unilateral failure of cerebral autoregulation has been shown after experimental occlusion of the middle cerebral artery, and this may remain up to three years. In patients who have suffered an acute stroke autoregulation may also be impaired in the affected hemisphere. Fazekas and Alman have suggested that when this occurs cerebral vessels are already maximally dilated on the side where the circulation is compromised by the effect of ischaemic cerebral vascular disease. Even a minor fall in perfusion pressure may then result in a fall in cerebral blood flow.
Postural hypotension is commonly found both in hospital inpatients with symptoms and asymptomatic elderly patients living in the community. Variations in cerebral autoregulation would explain why some elderly people with minor falls of systemic arterial pressure develop clinical signs of cerebral ischaemia, whereas others with greater falls in blood pressure remain asymptomatic. They may also explain why transient cerebral dysfunction is common in elderly patients with cardiac dysrhythmias and the varying effect of hypnotic drugs in the elderly. Elderly patients with impaired cerebral autoregulation may be at risk of brain damage from minor falls in blood pressure.

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References


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