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Human cerebral circulation: positron emission tomography studies

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We reviewed the literature on human cerebral circulation and oxygen metabolism, as measured by positron emission tomography (PET), with respect to normal values and of regulation of cerebral circulation. A multicenter study in Japan showed that between-center variations in cerebral blood flow (CBF), cerebral blood volume (CBV), cerebral oxygen extraction fraction (OEF) and cerebral metabolic rate of oxygen ($CMRO_2$) values were not considerably larger than the corresponding within-center variations. Overall mean ± SD values in cerebral cortical regions of normal human subjects were as follows: CBF = 44.4 ± 6.5 m*l*/100 m*l*/min; CBV = 3.8 ± 0.7 m*l*/100 m*l*; OEF = 0.44 ± 0.06; $CMRO_2$ = 3.3 ± 0.5 m*l*/100 m*l*/min (11 PET centers, 70 subjects). Intrinsic regulation of cerebral circulation involves several factors. Autoregulation maintains CBF in response to changes in cerebral perfusion pressure; chemical factors such as P_aCO_2 affect cerebral vascular tone and alter CBF; changes in neural activity cause changes in cerebral energy metabolism and CBF; neurogenic control of CBF occurs by sympathetic innervation. Regional differences in vascular response to changes in P_aCO_2 have been reported, indicating regional differences in cerebral vascular tone. Relations between CBF and CBV during changes in P_aCO_2 and during changes in neural activity were in good agreement with Poiseuille's law. The mechanisms of vascular response to neural activation and deactivation were independent on those of responses to P_aCO_2 changes. CBV in a brain region is the sum of three components: arterial, capillary and venous blood volumes. It has been reported that the arterial blood volume fraction is approximately 30% in humans and that changes in human CBV during changes in P_aCO_2 are caused by changes in arterial blood volume without changes in venous blood volume. These findings should be considered in future studies of the pathophysiology of cerebrovascular diseases.

Key words: cerebral circulation, PET, autoregulation, P_aCO_2, neural activity