

Cerebrovascular Dynamics Differentiate Sleep Apnea Subtypes

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Objective: Determine vascular pathophysiology and prevalence of sleep apnea in patients referred for cerebrovascular evaluation to elucidate a major stroke risk factor.

Background: Sleep apnea is associated with stroke and this is likely related in part to vascular physiology. The physiological state of the cerebral circulation can be measured directly, by an objective new method for processing transcranial Doppler (TCD) data, Dynamic Vascular Analysis (DVA, J Neuroimaging, in press).

Design/Methods: Patients (115 of 285 consecutive consultations) referred for neurovascular evaluation of TIA and other cerebral vascular disorders and who had a clinical history suspicious for sleep apnea underwent a TCD and a polysomnogram. The TCD data were studied retrospectively using DVA (with age- and gender-matched z-scores compared to asymptomatic subjects) and the vascular physiological state was examined for correlation with the apnea-hypopnea indices. Multivariate analyses identified significant segmental, regional and ensemble vascular indices which explained most of the variance. Receiver-operator curves were generated to ascertain the sensitivity and specificity of DVA in sleep apnea screening and evaluation.

Results: Polysomnography revealed that 75 of 115 subjects had sleep apnea, a prevalence exceeding 25% among patients referred for a CNS syndrome, such as TIA. Univariate analysis with R-values exceeding 0.2 are described. In REM-associated apnea, there was a low Dynamic Pressure Ratio ($DPR = \text{Systolic Acceleration (lnSA)}/PI$) in all posterior vessels (VA, BA, P1, P2) and in C2 and A1. A low Dynamic Flow Index ($DFI = \text{Mean Flow Velocity (MFV)}/\text{Index of Pulsatility (PI)}$) was seen in VA, BA, P2 and C2. High Dynamic Work Index ($DWI = \ln SA/MFV$) was seen in VA, P2, and C2. In positional apnea, DPR was low in BA, P1, A1, and C4. Low DFI was seen in VA, P2 and C4. The DWI was increased in VA, P2, C4, and OA. Multivariate analysis revealed that DVA indices in the A1, BA and VA could be used generate a receiver-operator curve yielding a 95% sensitivity and 50% specificity.

Conclusions: Posterior microcirculation impairment correlated with REM-associated sleep apnea, suggesting that diminished perfusion of the medulla may “stun” the medullary respiratory drive centers and limit the respiratory drive required during REM-associated muscular hypotonia. Anterior circulation vasodilatation may be a response to clinically significant sleep apnea-related hypercarbemia or hypoxemia. Postural sleep apnea patients also have impaired anterior lobe impedances suggesting diminished intracranial compliance - secondary to vasodilatation or marginally elevated intracranial pressure. Dynamic vascular indices may predict a positive polysomnogram in patients suspected to have sleep apnea and should be studied further for use as a screening test. Finally, the findings suggest that the prevalence of sleep apnea in CNS syndromes is much higher than previously expected.