

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, April 2004).

Sleep disordered breathing is associated with the development of hypertension and increased right to left cardiac shunting with resultant increased risk of cerebral emboli.

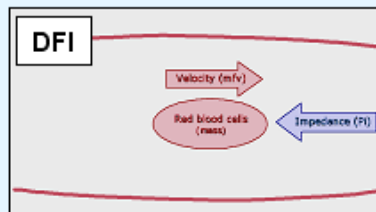
Methods

Patients underwent full transcranial Doppler studies with mean flow velocity (MFV), pulsatility index (PI), and acceleration (SA) as well as full polysomnography.

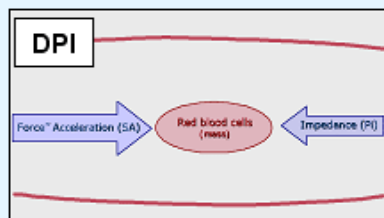
Dynamic Vascular Analysis (DVA) was performed retrospectively on all Doppler spectral waves yielding the dynamic flow index (DFI), dynamic perfusion index (DPI) and the dynamic work index (DWI).

Data were analyzed comparing the DVA indices with apnea-hypopnea indices.

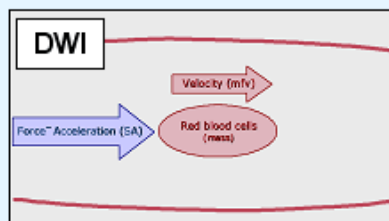
DVA indices from disease specific categories were referenced to an asymptomatic data set to generate standard deviation (z-) scores.



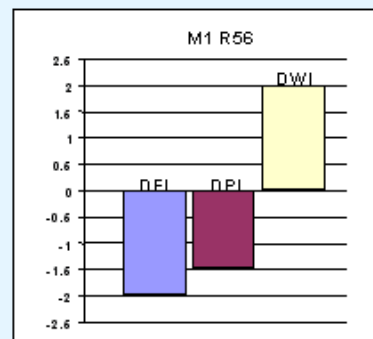
$$DFI = MFV/PI$$



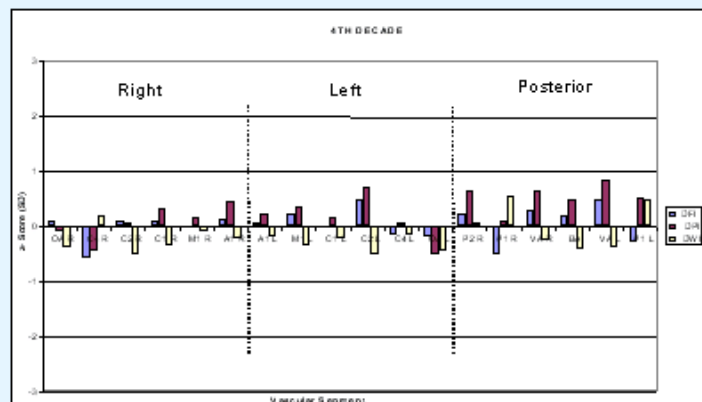
$$DPI = \ln SA/PI$$



$$DWI = \ln SA/MFV$$

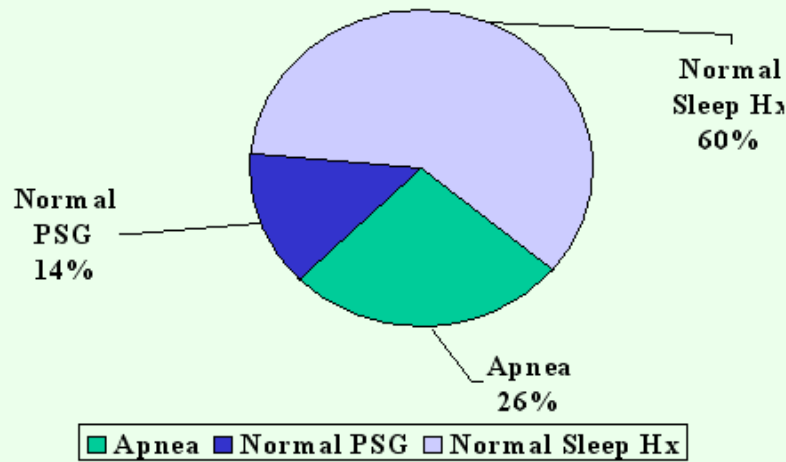


Combined, the three indices related to mean values from a reference population, generates a segmental z-score bar graph output (above) for an ensemble of segments (below).



Findings

285 Neurovascular Referrals



Polysomnography revealed that 75 of 115 subjects had sleep apnea, a prevalence exceeding 25% among patients referred for a CNS syndrome, such as TIA.

DVA patterns of vascular involvement differentiated apnea subtypes with univariate analysis having R-values exceeding 0.2.

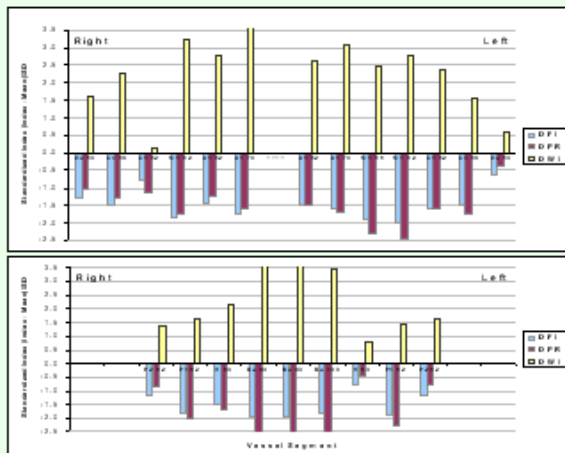
REM-Associated Apnea

Low DPI in VA, BA, P1, P2, C2 and A1
Low DFI in VA, BA, P2 and C2
High DWI in VA, P2, and C2

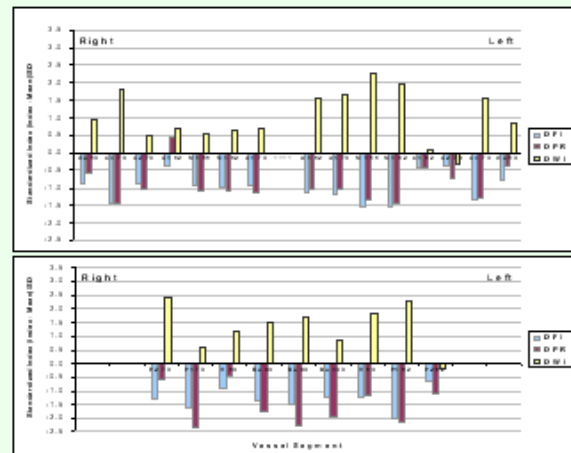
Positional Apnea

Low DPI in BA, P1, A1, and C4
Low DFI in VA, P2 and C4
High DWI in VA, P2, C4, and OA

Case Study: Apnea - Pre-CPAP

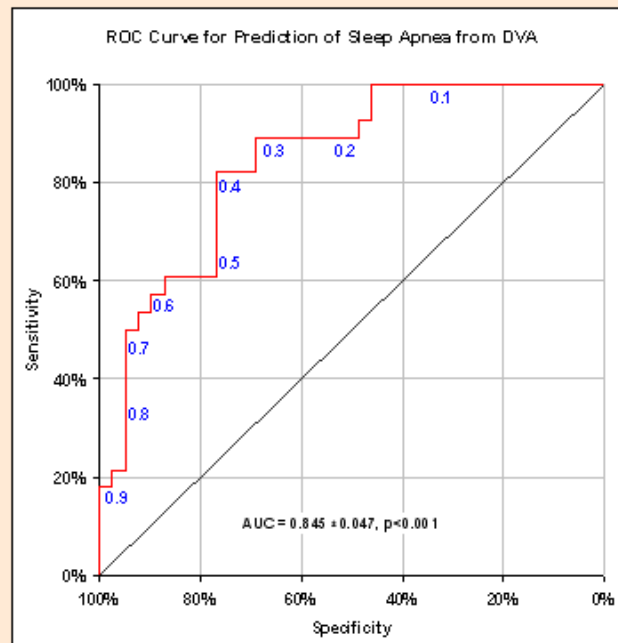


Apnea: Post-CPAP



Single patient pre- and post-CPAP therapy showing global vasodilation with normalization on CPAP.

Discussion



Multivariate analysis indicated that DVA indices of the A1, BA and VA would best differentiate sleep apnea and were used to generate the above receiver-operator curve.

The ROC shows that sensitive or specific DVA criteria may be developed, depending on the clinical need as a screening or confirmatory tool.

Summary

Posterior microcirculation impairment correlated with REM-associated sleep apnea, suggesting stunning of the medullary respiratory drive centers during REM-associated muscular hypotonia.

Anterior circulation vasodilatation may be a response to clinically significant sleep apnea-related hypercarbia or hypoxemia.

Postural sleep apnea patients 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 of sleep apnea and should be studied further for use as a screening test.

The prevalence of sleep apnea in CNS syndromes is much higher than previously expected.

A thorough consideration of sleep apnea is warranted in patients with a CNS syndrome, particularly TIA.