

Introduction

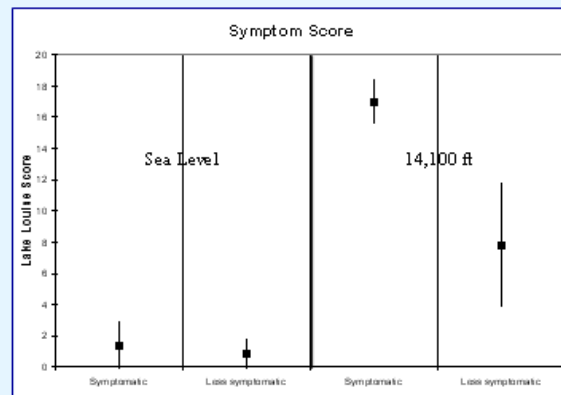
One cause of Acute Mountain Sickness (AMS) may be impaired endothelial function characterized by increased permeability to macromolecules, increasing interstitial free water, causing High Altitude Cerebral Edema (HACE) and High Altitude Pulmonary Edema (HAPE). In this study we elucidated how symptoms that occur with altitude relate to altered cerebrovascular dynamics and serum levels of vascular endothelial growth factor (VEGF).

Methods

Nine volunteers who ascended from sea level to Pike's Peak summit (14,100ft) underwent transcranial Doppler (TCD) studies with Dynamic Vascular Analysis (DVA). Comprehensive Doppler ultrasound measurements were taken from both middle cerebral M1 (50-60 mm), both anterior cerebral A1 (60-70mm), both posterior cerebral, P1 (60-70mm) and P2 (60-70mm), both vertebral (60-65mm) and the basilar arteries (80-100mm). Serum VEGF levels, Lake Louise Scores, Spielberg Scores, SEES Positive Scores, and Symptom Checklist surveys were collected after 24 hours at various altitudes.

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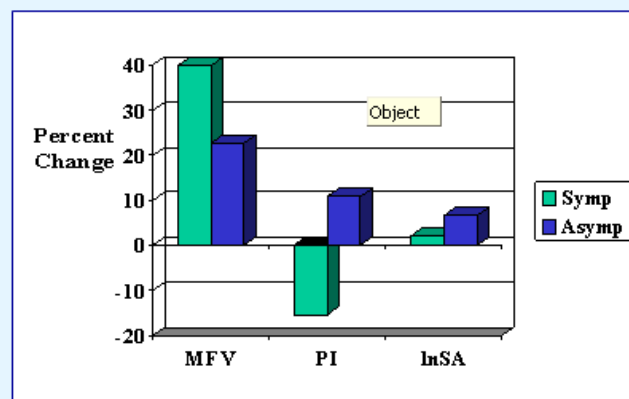
Symptom scores differentiated the subjects into two discrete groups



- Subjects sorted into a symptomatic group (n=3) and a relatively asymptomatic group (n=6)
- Two other symptom scales showed similar results
- One symptomatic subject developed HACE (papilledema) at 14,100 ft

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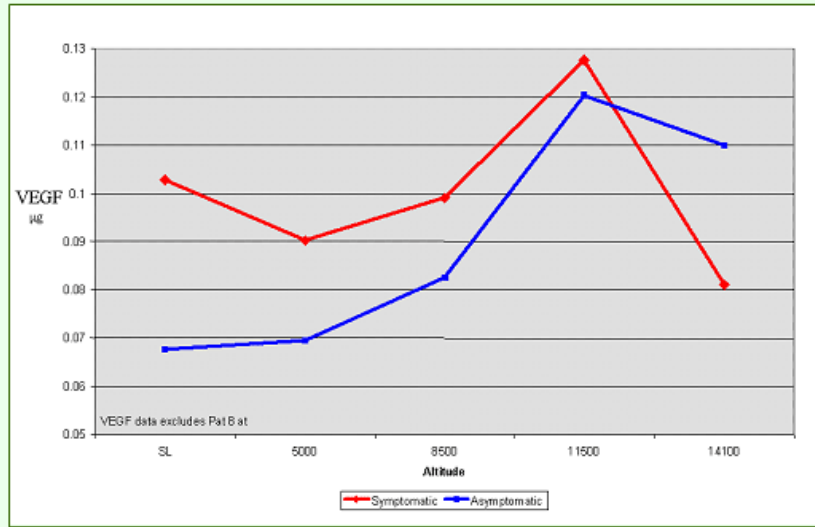
The index of pulsatility (PI) best differentiated the two groups



- Both groups had increased velocities (MFV) at altitude consistent with previous TCD altitude studies
- Index of pulsatility (PI) revealed arteriole capacitance and conductance vessel impedance
- ln Systolic Acceleration (lnSA) changed by less than 10%

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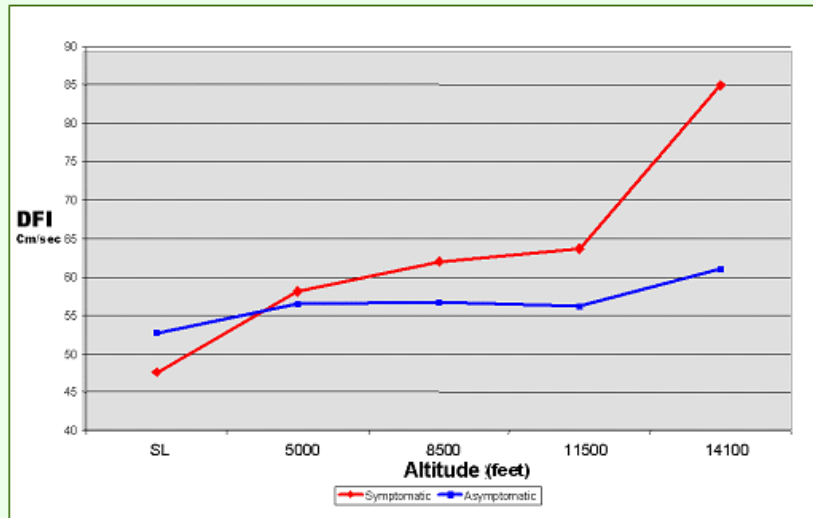
Symptomatic subjects had high VEGF levels at sea level but low levels at 14,100 ft.



- Decreasing VEGF levels with hypoxemia (altitude) may be secondary to receptor binding or interstitial extravasation through opened gap junctions

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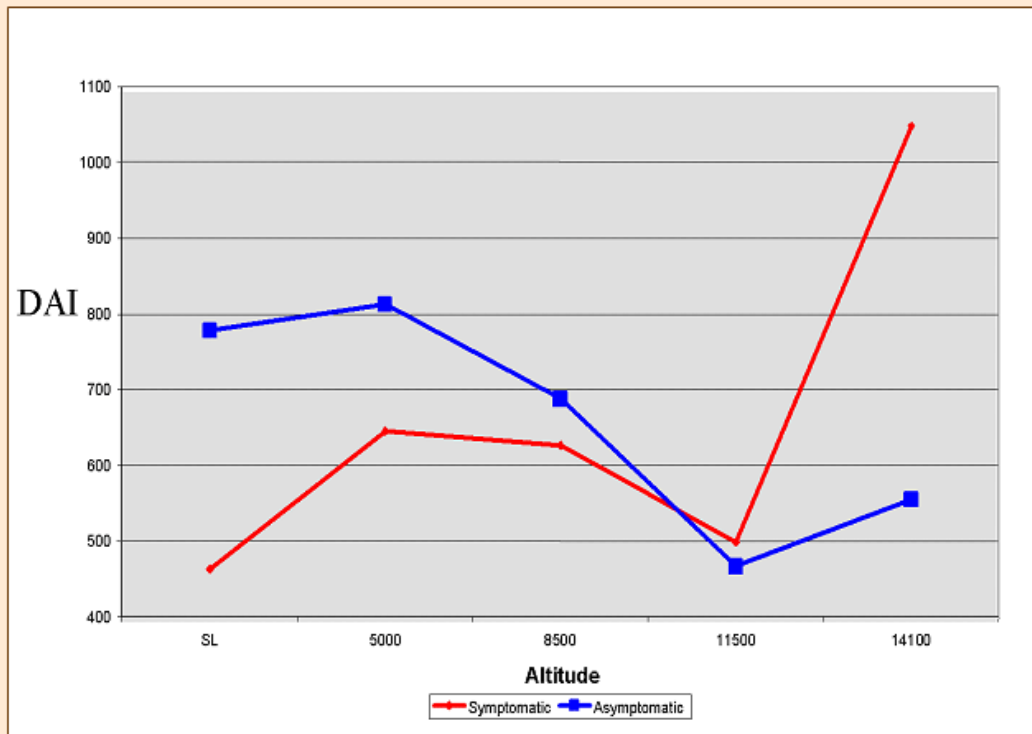
Dynamic Flow Index (DFI) increased in symptomatic subjects at 14,100 feet



- DFI [Dynamic Flow Index] is the ratio of MFV/PI
- The increase of 70.2% in DFI in the symptomatic subjects compared to the 11.8% increase in the asymptomatic subjects
- The relationship of capacitance vessels (arterioles and capillaries) to conductance vessels (Circle of Willis) is defined by DFI

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The ratio of DFI to VGEF (Dynamic Altitude Index, DAI) may be a predictor of AMS



◦ The difference of 32.5% difference at 14,100 feet indicates the physiological response to hypoxic stress, which causes Acute Mountain Sickness

Conclusions

- ❑ Vascular dysfunction mediates AMS
- ❑ Increasing vascular permeability increases arteriole capacitance
- ❑ Significantly increased vascular permeability resulted in HACE in one subject
- ❑ DVA demonstrated vascular pathophysiology of AMS
- ❑ VEGF changes are meaningful in the context of DVA findings
- ❑ At sea level, the Dynamic Altitude Index may predict AMS
- ❑ The findings may help explain ischemia in myocardial infarction, stroke, dementia, peripheral vascular disease and diabetic retinopathy