Nasal Morphology and Blood Flow During Augmented Air Pressure Breathing Therapies

White, D.E.,[1], Al-Jumaily, A.M.,[1], Bartley, J.[2], Lu, J.[1], Hankin, R.K.S.[3]

[1]Institute of Biomedical Technologies, Auckland University of Technology, Auckland, New Zealand.
[2]Department of Surgery, University of Auckland, Auckland, New Zealand.
[3]School of Computing and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand.

ABSTRACT

Air delivered under augmented pressure during breathing therapy normally requires external humidification in order to avoid upper airways dryness and discomfort. Nasal heat and water flux between air and mucosa is dynamically regulated through changes in the erectile tissue volume. This investigation utilizes magnetic resonance imaging to investigate the effects augmented air pressure has on the erectile tissue size and blood flow. Eight healthy participants, aging from 18 to 56 years of mixed gender and ethnicity, undertook head MRI scans during two breathing conditions, ambient and pressurized air. For the latter, each participant experienced one augmented pressure level, ranging from 6 to 15 cmWG in increments of 3 cmWG. This was delivered through a nasal mask using a commercially available continuous positive airway pressure device. Geometrical analysis of images obtained for the region spanning the anterior inferior turbinate to the posterior choanae was undertaken. Results demonstrate a reduction in patent airway volume occurs during breathing at low pressure augmentation whist the congested airway volume remains relatively constant. Increasing pressure results in an opposite response where the congested airway volume increases whilst the patent volume remains unchanged. Only at the highest pressure (15 cmWG) did both patent and congested airways respond in a way consistent with previous observations of tissue compliance (which were based on acoustic rhinometry and modeling). The counter response of the patent airway and independence of reaction between each nasal passage at low to mid pressures is inconsistent with earlier work which detected no differences in morphological response between patent and congested nasal airways. This inter-nasal variation in behavior may be attributed to redistribution in blood occurring within the nasal erectile tissue. Using arterial spin labeling, this research has also qualitatively assessed the changes in nasal blood flow to each side of the nose. Whilst this technique does not indicate total blood volume and hence state of erectile-tissue engorgement, it does identify changes in blood flow occur in both congested and patent airways during pressurized breathing.