Application of MATLAB Digital Image Analysis to Measure Pharyngeal Wall Compliance in Obese Adolescents with Sleep Apnea

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Background: Obesity is a major risk factor for pediatric obstructive sleep apnea (OSA); however, the exact pathophysiologic mechanism remains unclear. The purpose of this study was to measure pharyngeal wall compliance in obese adolescents using MATLAB program analysis of cine MR imaging and to compare pharyngeal wall compliance between adolescents with OSA and those without OSA.

Methods: A MATLAB program developed by the Department of Aerospace Engineering at the University of Cincinnati was used to analyze the cine MR images. The images were taken in the identical axial plane at the mid-tongue level, corresponding to the base of the C2 vertebra. Images were taken once per second throughout the respiratory cycle, and 128 images total were taken and analyzed per subject. The MATLAB program analyzed the images by first determining an airway boundary and then using this determination to directly calculate the airway cross-sectional area. For each subject, the ten maximum cross-sectional areas and the ten minimum areas were averaged to determine the upper and lower limits of the airway range, respectively. Pharyngeal compliance was then defined as the normalized range, or the range divided by the average cross-sectional area of all 128 images. The OSA and control groups were then compared using unpaired student's t test or Wilcoxon test for continuous variables and Fischer's exact test for categorical variables.

Results and Conclusions: The imaged control group (n=11) did not differ from the OSA group (n=10) in their age or gender. The normalized range of the airway cross-sectional areas in the control group was 0.49 (±0.15) compared to the OSA group normalized range of 0.68 (±0.17) ($p=0.014$), leading us to conclude that a significant difference exists in the wall compliance between the groups. This also led us to conclude that increased pharyngeal compliance likely plays an important role in the pathogenesis of OSA among obese adolescents.