

## Upper Airway Collapsibility Assessed By Negative Expiratory Pressure While Awake Is Associated With Tongue Dimensions And Hyoid Position

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**Rationale:** Upper airway anatomy is likely the dominant factor contributing to obstructive sleep apnea (OSA). Pharyngeal critical closing pressure ( $P_{crit}$ ) measured during sleep correlates with anatomy. However, this is a laborious method that requires experienced investigators. The application of negative expiratory pressure (NEP) can be easily performed during wakefulness. We hypothesized that NEP applied through a nasal mask in the supine position would reflect upper airway collapsibility and would correlate with upper airway anatomy. We also hypothesized that upper airway collapsibility measured during sleep ( $P_{crit}$ ) and while awake (NEP) represent different mechanisms of pharyngeal collapse, and could be independent predictors of OSA severity.

**Methods:** We performed full overnight polysomnography, computed tomography scans of the upper airway, NEP and  $P_{crit}$  in 28 male subjects (age =  $45 \pm 13$  yrs, body mass index =  $29.4 \pm 4.9$  kg/m<sup>2</sup>, neck circumference =  $41.0 \pm 3.4$  cm, apnea-hypopnea index (AHI) =  $30.0 \pm 26.3$  - range 1.9 to 85.8). NEP was performed with  $-5$  cmH<sub>2</sub>O in supine position using a nasal mask. NEP was defined as the ratio between mean exhaled volume at 0.2s of the three preceding expirations and the exhaled volume at 0.2s during NEP application ( $V02p/V02NEP = 0.51 \pm 0.25$  - range 0.21 to 1.18).  $P_{crit}$  was determined in supine position during midazolam-induced sleep ( $P_{crit} = -0.69 \pm 3.04$  cmH<sub>2</sub>O - range -7.24 to +6.20).

**Results:** Correlations between upper airway collapsibility and upper airway anatomy are presented in the Table below.  $V02p/V02NEP$  was also correlated with AHI ( $r=0.49$ ,  $p=0.009$ ) and  $P_{crit}$  ( $r=0.39$ ,  $p=0.04$ ).  $V02p/V02NEP$  and  $P_{crit}$  accounted for 37.4% of the AHI variance ( $p=0.003$ , standardized beta coefficients of 0.403 and 0.329, respectively).

**Conclusions:** NEP is a simple and promising method that can be performed during wakefulness to evaluate upper airway collapsibility. NEP is associated with upper airway anatomic features of OSA patients such as increased tongue dimensions and hyoid position. The independent contribution of NEP and  $P_{crit}$  to OSA severity suggest that each method evaluates different characteristics of the propensity for upper airway collapse.

	NEP		Pcrit	
	Wakefulness		Sleep	
	r	p	r	p
Tongue area	0.646	<0.0001	0.585	0.001
Tongue volume	0.565	0.002	0.613	<0.0001
Tongue height	0.548	0.003	0.381	0.038
Soft palate length	0.472	0.011	0.612	<0.0001
MPH	0.432	0.024	0.705	<0.0001
PNS-H	0.628	<0.0001	0.719	<0.0001
Pharyngeal length	0.580	0.001	0.611	<0.0001

MPH, mandibular plane to hyoid distance; PNS-H, posterior nasal spine to hyoid distance.

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