Does negative pressure applied to the submandible region improve collapsibility of the passive pharyngeal airway?

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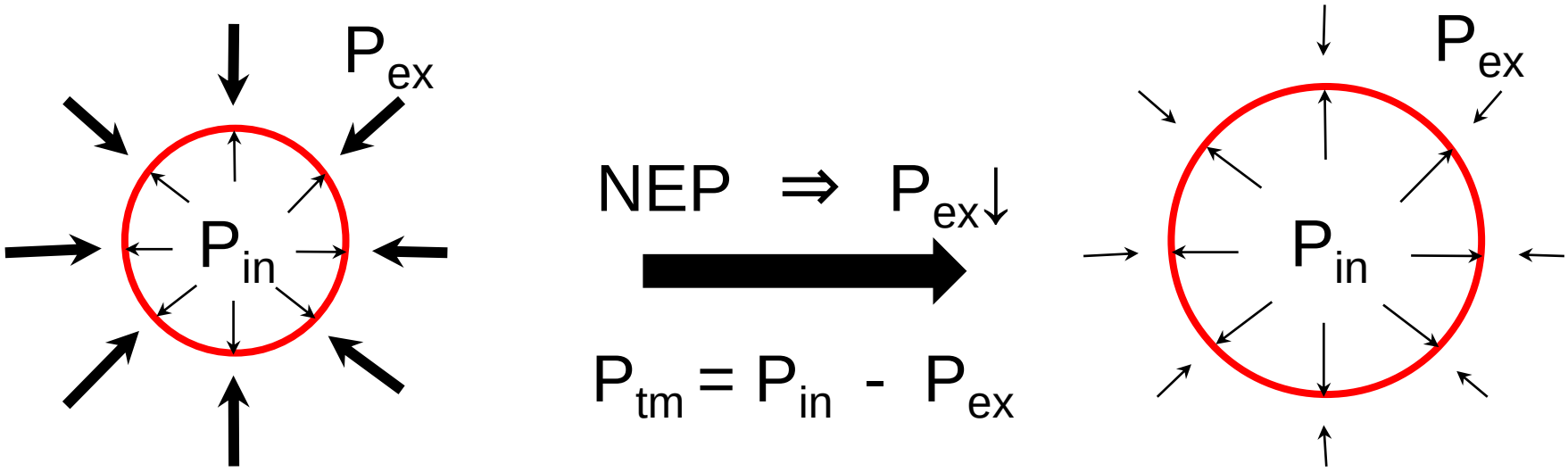
Introduction

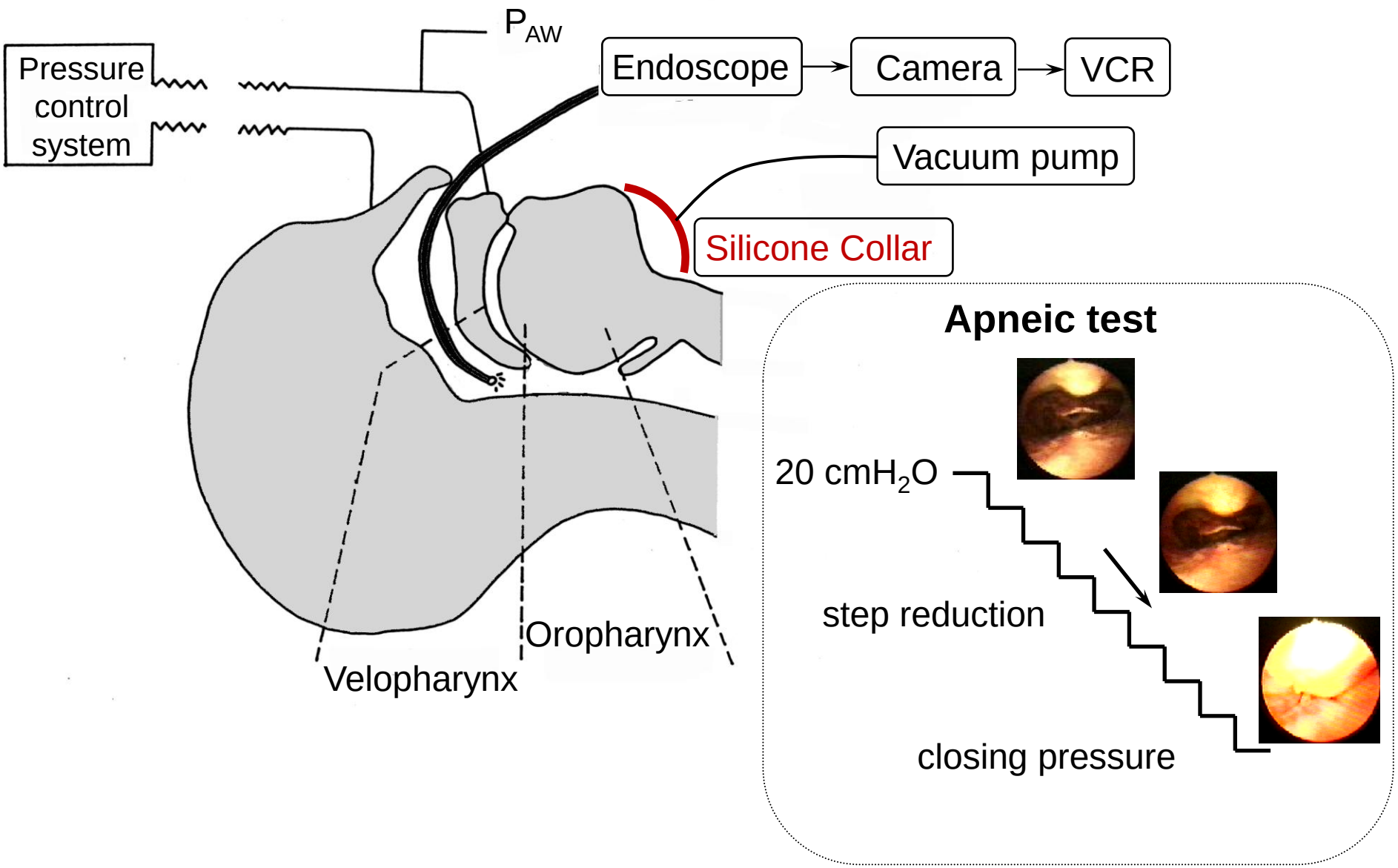
- The passive pharynx behaves like a collapsible tube. Cross-sectional area of the tube is determined by transmural pressure, the difference between intraluminal and extraluminal pressure.
- Dependence of the pharyngeal cross-sectional area on the intraluminal pressure is well documented.
- We lack knowledge of influences of the extraluminal pressure on the pharyngeal airway patency particularly in humans.

Hypothesis

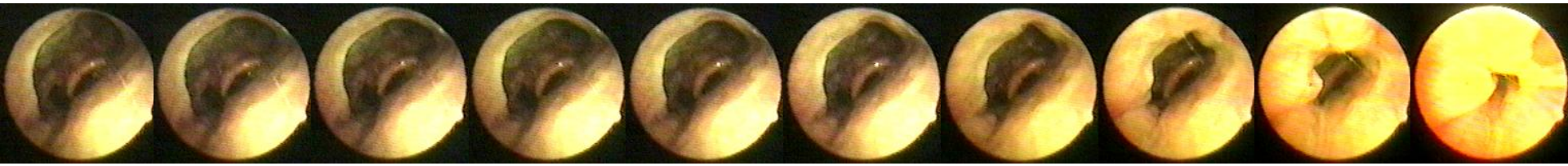
Negative external pressure (NEP) application to the submandible region improves pharyngeal airway collapsibility.



Assessment of passive pharyngeal airway collapsibility under general anesthesia and paralysis



Static pressure/area relationship of the passive pharynx

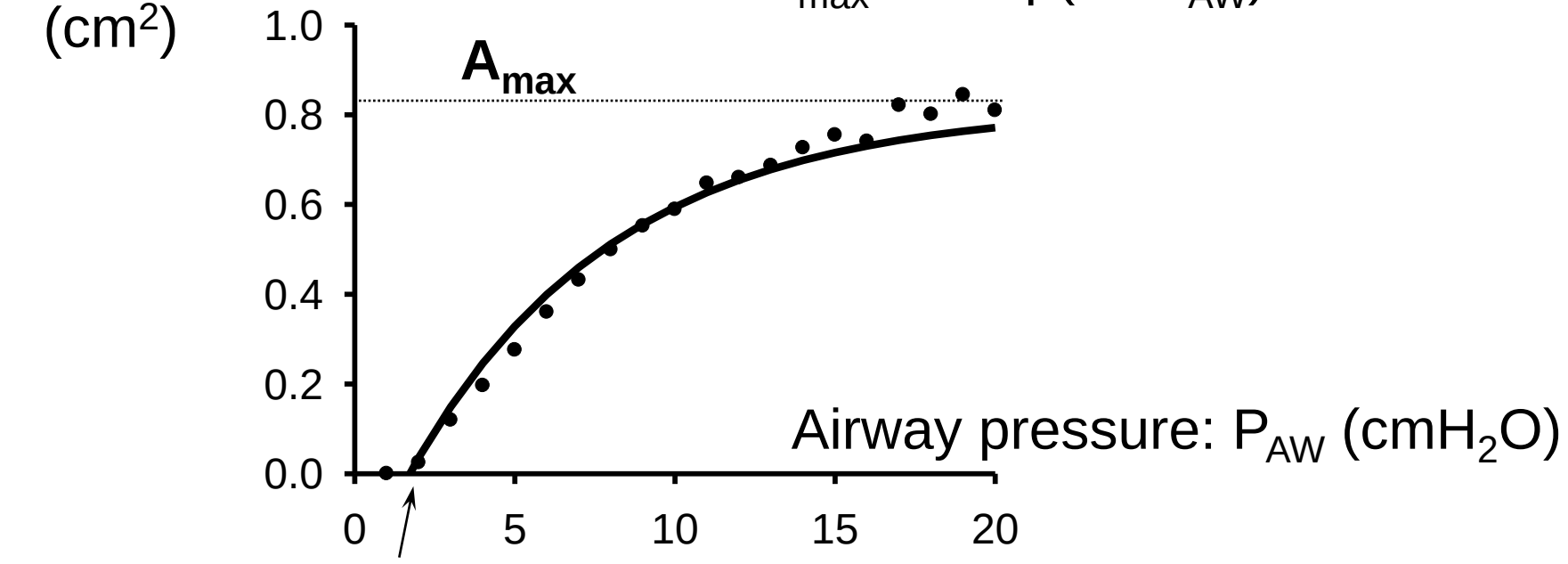


20 18 16 14 12 10 8 6 4 2

(cmH_2O)

Curve fitting analysis

$$A = A_{max} - B*\exp(-K*P_{AW})$$

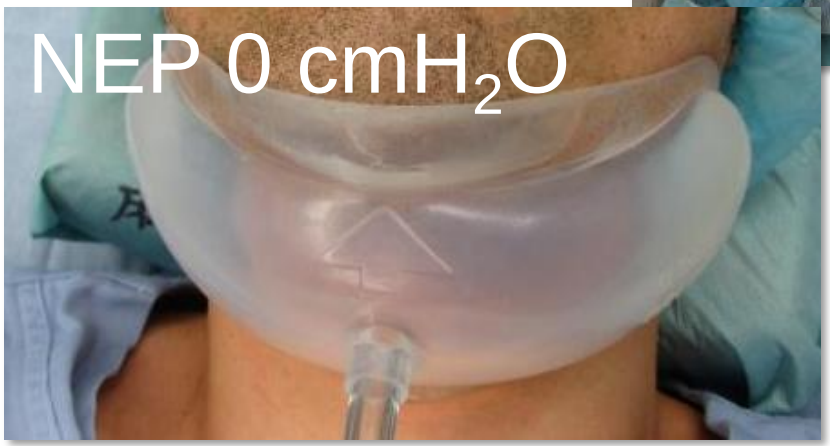


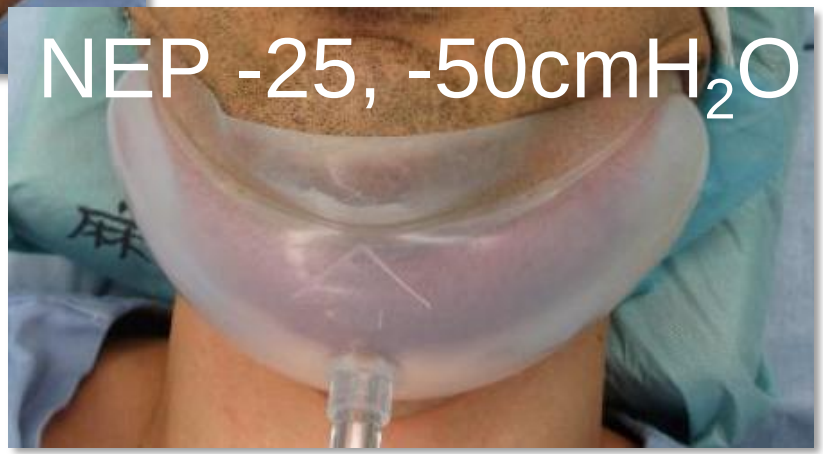
$$\mathbf{P'_{close}} = \ln(B/A_{max})K^{-1}$$

Measurements

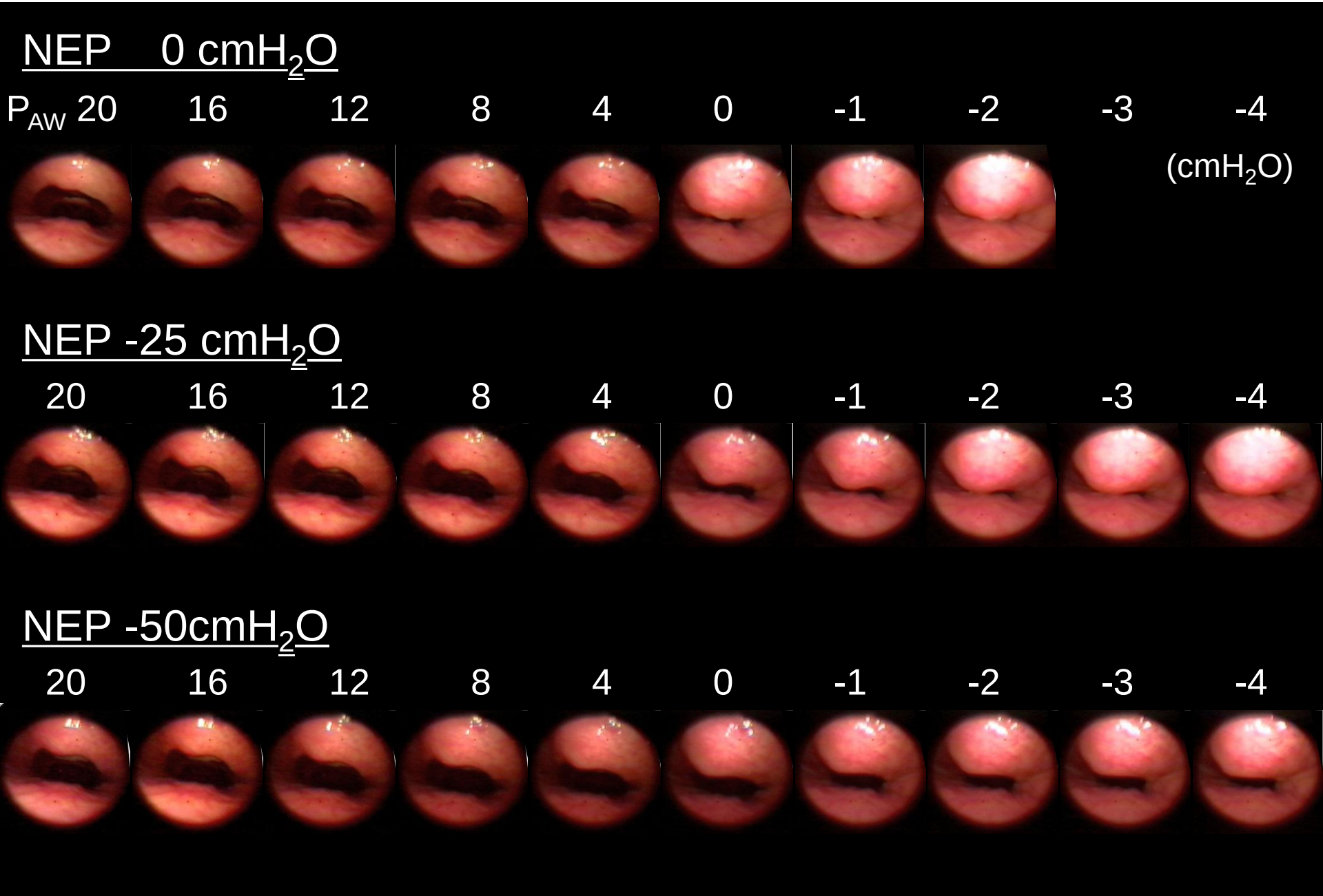
Static pressure / area relationship of the velopharyngeal and oropharyngeal airway

NEP 0 cmH_2O *versus* NEP -25, -50 cmH_2O

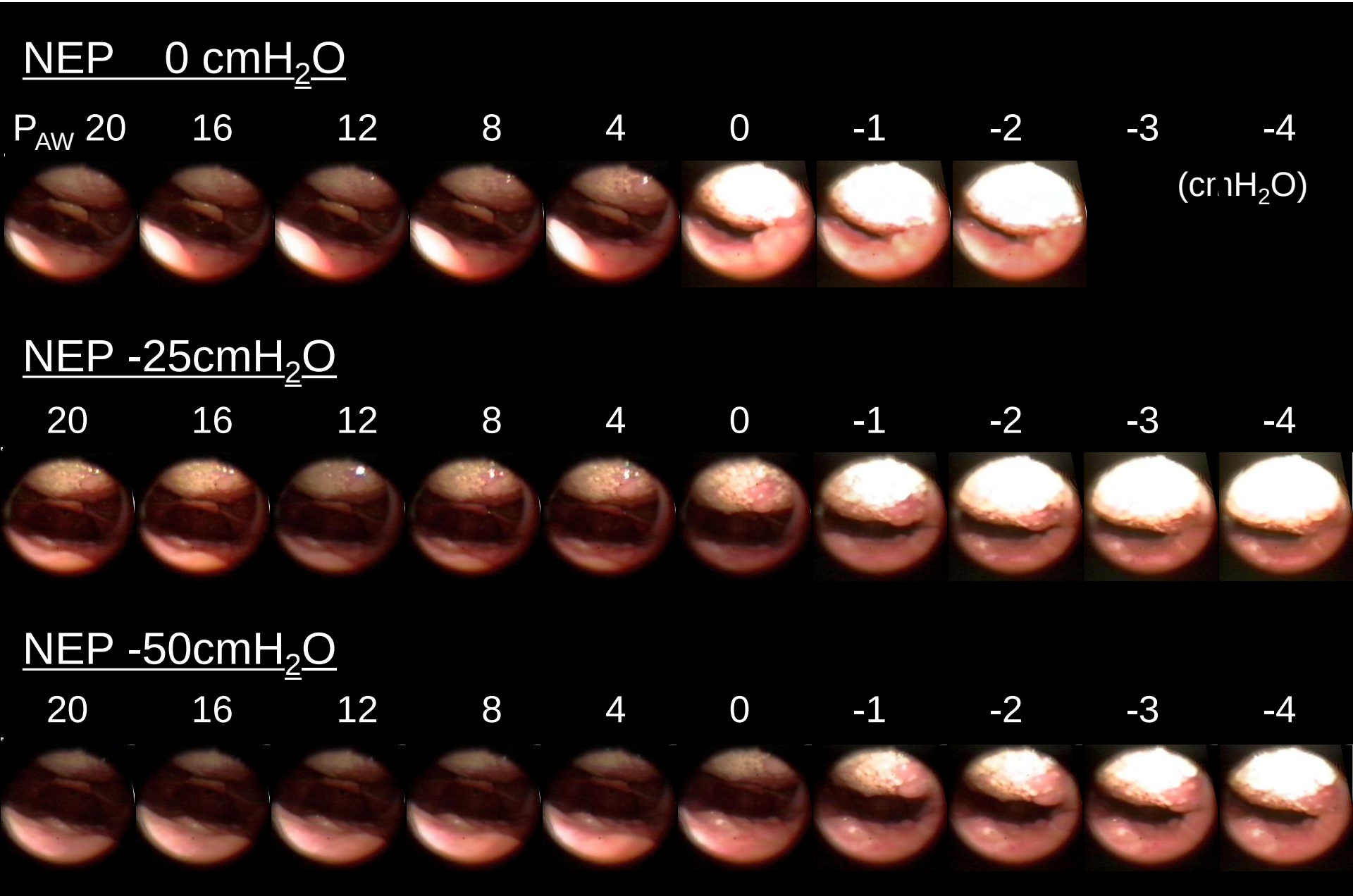




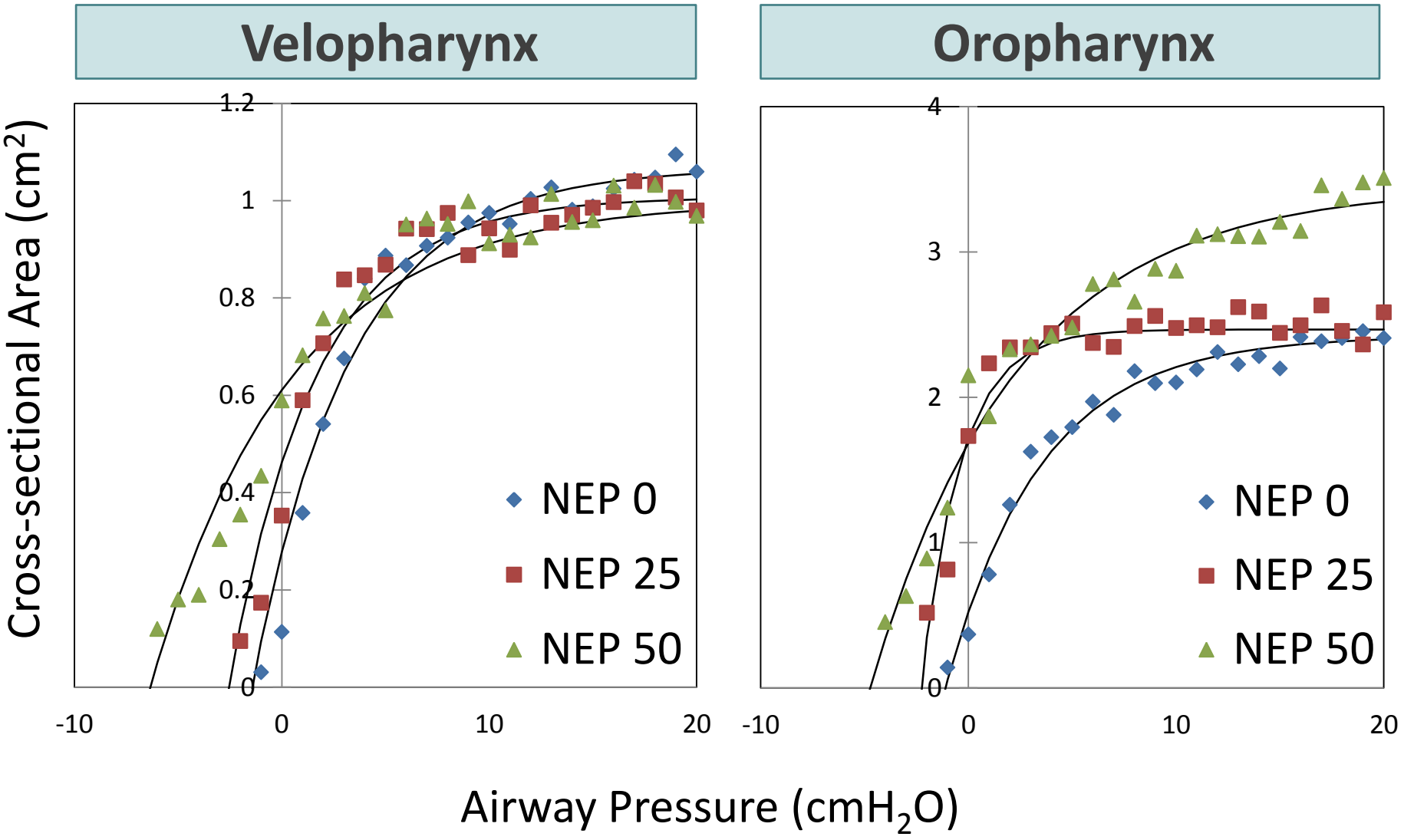
Velopharyngel CSA Changes



Oropharyngeal CSA Changes



Static Pressure-Area Relationships



Characteristics of the Patients (n=19)

	Mean ± SD (min to max)
Age	57 ± 11 (31 to 70)
Gender (male/female)	0/19
Height [cm]	154 ± 7 (140 to 167)
Weight [kg]	65 ± 20 (42 to 109)
BMI [kg/m^2]	27.4 ± 8.2 (17.9 to 45.7)
Mallampati class(I/II/III/IV)	6 / 9 / 2 / 2
Neck circumference [cm]	35.2 ± 4.6 (30 to 43.5)
3%ODI [/hour]	13.1 ± 12.4 (0.2 to 39.7)
CT_{90} [%]	2.6 ± 4.5 (0.0 to 14.2)
AHI [/hour]	14.5 ± 12.9 (0.2 to 39.7)

ODI: oxygen desaturation index, CT_{90}: percent of time spent with SpO_2 below 90%, AHI: Apnea Hypopnea Index

Results

Velopharynx	NEP 0	NEP -25	NEP -50
A_{max} [cm^2]	1.7±0.8	1.8±0.9	1.8±0.8*
P_{close} [cmH_2O]	-1.7±2.3	-3.6±3.2*	-3.3±2.8*
K value	0.23±0.13	0.18±0.07	0.19±0.07
ΔP_{close} [cmH_2O]		1.7±2.5	1.6±2.1
Number of Responder		6 / 18 (33%)	4 / 19 (21%)
Oropharynx	**NEP 0**	**NEP -25**	**NEP -50**
A_{max} [cm^2]	3.2±1.7	3.3±1.5	3.4±1.5
P_{close} [cmH_2O]	-1.3±1.9	-3.8±3.9*	-4.1±3.3*
K value	0.20±0.05	0.20±0.10	0.17±0.05
ΔPclose [cmH_2O]		2.3±3.3	2.8±2.7
Number of Responder		4 / 18 (22%)	4 / 19 (21%)
*: P<0.05 versus control			

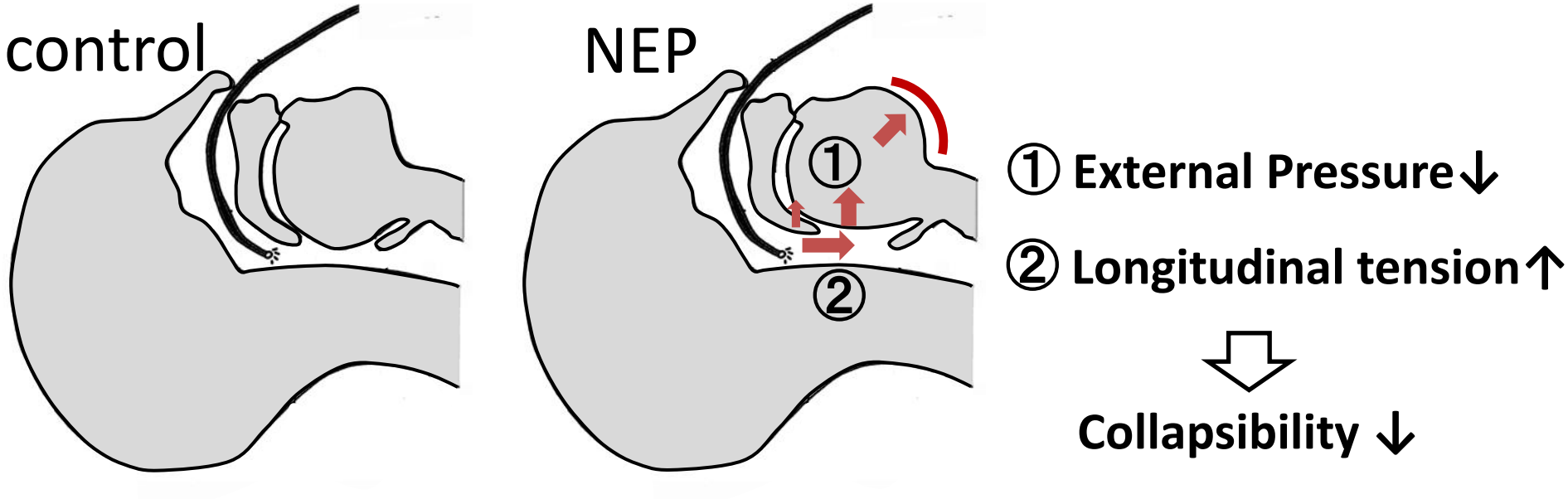
Responder: patients whose P_{close} decreased below -3.8 (velopharyx), and -5.5 (oropharynx) cmH_2O

(S.Isono et.al J Appl Physiol 1997)

Conclusion

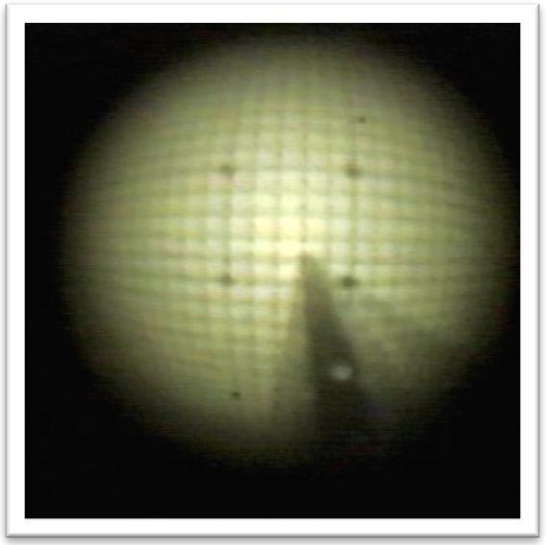
Negative external pressure (NEP) application to the submandible region improves pharyngeal airway collapsibility.

Possible Mechanism?



Acknowledgement

- Collars for NEP application and a NEP device (cNEP) are provided by Dr. Richard Rose (5i Sciences Inc.).



Wide angle
correciton filter