Safety Considerations Regarding Noninvasive Positive Pressure Ventilation Following Esophagectomy

To the Editor:

I read with great interest the article by Raman et al in a recent issue of CHEST (February 2015) that evaluated the pressure tolerance of esophagectomy anastomosis ex vivo and in vivo in a pig model in comparison with esophageal pressure during noninvasive positive-pressure ventilation (NPPV). The authors showed that anastomosis can tolerate higher pressures than those transmitted to the esophagus during NPPV, thus demonstrating the safety of NPPV after esophagectomy. Despite these data, however, in the clinical setting caution is necessary for several reasons when using pressures > 20 cm H2O during NPPV after esophagectomy.

First, the authors found significant variability in pressure tolerance using ex vivo and in vivo models. In their study, the lowest pressure tolerated by ex vivo anastomoses before leakage was 21 cm H2O.

Second, the risk of gastric insufflation during NPPV increases with pressure > 20 cm H2O. Even if a pressure of ≤ 15 cm H2O is considered safe, a pressure of 15 to 20 cm H2O is also acceptable for preventing gastric insufflation during NPPV. During NPPV, the ventilation volume is distributed between the lungs and stomach, depending on the respiratory system resistance and the esophageal sphincter pressure. The resting upper esophageal sphincter pressure is lower in elderly individuals compared with young people (24 ± 9 mm Hg vs 42 ± 14 mm Hg, P < .001). Furthermore, the protective function of the lower esophageal sphincter is generally lost after esophagectomy. In clinical esophageal surgery, postoperative gastric distention not only may cause decreased venous outflow and vascular congestion within a gastric conduit, but increasing the wall tension may potentiate the ischemic effects of gastric transposition for esophageal reconstruction.

Third, air escape from the stomach to the esophagus after gastric insufflation may induce transient upper esophageal sphincter relaxation. This effect is a consequence of receptor stimulation by the air pressure pulse in the esophagus, but not distortion of the esophagus or an increase in esophageal pressure. Upper esophageal sphincter relaxation may allow aspiration of gastric contents that may be associated with serious complications (ie, pulmonary aspiration and pneumonia). These complications should be prevented and managed by nasogastric tube placement for intermittent air and fluid aspiration, if possible, as well as aggressive acid reduction (ie, via IV administration of proton pump inhibitors). Thus, great care should be used not only to limit an increase in esophageal pressure, but, most importantly, to also reduce the risk of esophageal-gastric insufflation during NPPV after esophagectomy.

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References

Response
To the Editor:

We thank Dr Carron for the insightful remarks about our recent article in CHEST. Using a porcine model, we demonstrated that 20, 30, and 40 cm H2O of supralaryngeal positive airway pressure resulted in esophageal...
pressures of $5 \pm 4$ cm H$_2$O (25%), $11 \pm 11$ cm H$_2$O (37%), and $15 \pm 9$ cm H$_2$O (38%), respectively. This is a fraction of the pressure needed to disrupt an esophagogastric anastomosis.

We agree that noninvasive positive-pressure ventilation (NPPV) following esophagectomy may carry risks that need characterization in future studies. Our study showed variability in the pressure tolerance of anastomoses, as would be expected in the clinical setting. The lowest breaking pressure of 21 cm H$_2$O in one ex vivo sample may be attributable to ischemia of the tissue after explantation. More significant to the clinical setting, the lowest threshold in vivo was 54 cm H$_2$O. Our studies in human cadaveric esophagogastric anastomoses have demonstrated no pressure threshold below 59 cm H$_2$O and a mean pressure threshold of 107 cm H$_2$O (C. P. E., V. R., O. G. Ofoche, BS; unpublished data, January-August 2014). These models help establish the safe parameters for further study of NPPV in patients undergoing esophagectomy.

Dr Carron echoes our caution about gastric insufflation and aspiration with NPPV. In the setting of esophagectomy, gastric conduit distension may increase wall tension and decrease venous outflow, causing ischemia to the conduit and anastomosis.\textsuperscript{1,2} We agree with a comprehensive review of NPPV that advocates nasogastric tube decompression, airway pressures below 20 to 25 cm H$_2$O, and minimization of tidal volume.\textsuperscript{3} Regarding the risk of aspiration, a European trial of NPPV after esophagectomy used nasogastric tube suction and found no increase in the incidence of aspiration pneumonia.\textsuperscript{4}

Our work has shown that porcine gastric conduit and esophagogastric anastomoses can tolerate a much higher pressure than that received by the esophagus during NPPV. However, as outlined here and in our article, further human studies are necessary to firmly establish the safety of NPPV in patients undergoing esophagectomy.

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