Emergency percutaneous transtracheal ventilation in an obstructed airway model in sheep: oxygenation, airway pressure and carbon dioxide clearance using the Ventrain® and Manujet®.

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Background:
Temporizing oxygenation by percutaneous transtracheal ventilation (PTV) using a narrow bore transtracheal catheter (TC) and a high pressure oxygen source is a recommended emergency technique in 'can't intubate, can't oxygenate' (CICO) situations. The effectiveness of oxygenation and ventilation and the risk of barotrauma are affected by the degree of proximal airway obstruction. Several different devices for PTV are commercially available but performance may differ with the degree of obstruction. Despite this there is little comparative data to inform optimal device selection.

Aim:
To compare key physiological outcomes (oxygenation, ventilation and airway pressure) following PTV using two different devices in a large animal obstructed airway model.

Methods:
Prospective ethics approval was obtained. Healthy adult ewes (n = 5) were anaesthetised, intubated and invasively monitored. Two TCs were positioned under bronchoscopic guidance. Following paralysis and apnoeic desaturation (SaO_2 70%), PTV was performed for fifteen minutes using either the Manujet® (M) or Ventrain® (V) with the proximal airway either completely (O) or partially (2.1mm diameter expiratory airway) (P) obstructed. The four groups (MO, MP, VO,VP) were studied in random order in each animal. In each group, an initial 4 second breath was followed by secondary breaths of 2 seconds duration whenever the airway pressure fell below 10cm H_2O.

Results:
Key physiologic outcomes after fifteen minutes of PTV reflected both the device used and the degree of airway obstruction. No barotrauma occurred.

		MO (n=5)	MP (n=5)	VO (n=5)	VP (n=5)
PaO_2 (mmHg)		170 ± 50 [a]	430 ± 50 [b]	390 ± 50 [b]	400 ± 50 [b]
Initial Breath P_{max} (cm H_20)	****	41 ± 3 [a]	43 ± 3 [a]	18 ± 3 [b]	17 ± 3 [b]
Secondary Breath P_{max} (cm H_20)	**	21 ± 3 [ab]	32 ± 3 [a]	20 ± 3 [ab]	12 ± 3 [b]
MV ($Lmin^{-1}$)	****	0.2 ± 0.4 [a]	0.9 ± 0.4 [a]	4.3 ± 0.4 [b]	4.3 ± 0.4 [b]
pH	****	7.00 ± 0.03 [a]	7.17 ± 0.03 [b]	7.32 ± 0.03 [c]	7.28 ± 0.03 [bc]
$PaCO_2$ (mmHg)	****	112 ± 6 [a]	78 ± 6 [b]	51 ± 6 [c]	57 ± 6 [bc]

Differences between devices are indicated by symbols; M vs. V, **** p<0.0001, **p<0.01. Letters indicate the effect of interaction between device and airway obstruction; columns not linked by the same letter are significantly different from one another (p<0.05). Data are mean ± SEM.

Conclusions:
Both devices achieved rapid re-oxygenation. The Ventrain achieved this with low airway pressures and near normal minute ventilation. The Manujet generated higher pressures with barotrauma risk managed by reducing minute ventilation. Understanding these devices may help inform device choice and method in CICO situations with and without critical proximal airway obstruction.