Flow-Controlled Ventilation using a novel ultra-thin endotracheal tube (Tritube) during laryngo-tracheal surgery

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Background

The selection of appropriate strategies for managing the airway remains a challenge in patients requiring upper airway surgery. To fulfill the need for a tubeless surgery field, techniques such a apneic oxygenation or jet ventilation may be used. While these provide an increased surgical exposure, they carry risks of desaturation, air-trapping and barotrauma, aspiration, or aerosol generation.

In our institution, we currently use the mechanical ventilator Evone® (Ventinova, Eindhoven, The Netherlands), which implements flow-controlled ventilation (FCV), in selected cases of upper airway surgery. The low and constant flow during both inspiration and expiration enables the use of an ultrathin 4.4-mm outer diameter, 2.4-mm inner diameter, 40-cm long, cuffed endotracheal tube (Tritube®) that fits even stenotic airways, while ensuring optimal surgical exposure.

Results

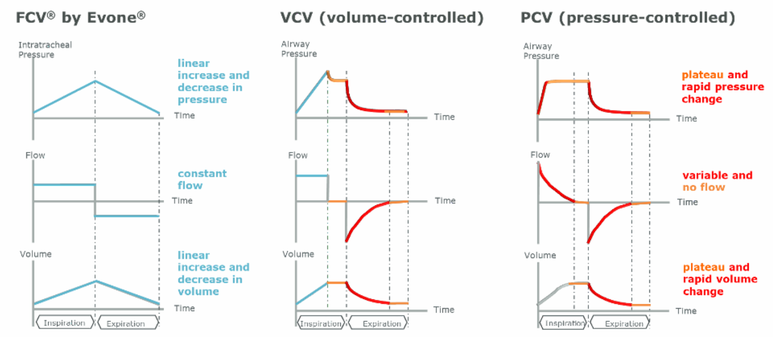
Fourteen patients with median age of 64 years (range 47–79 years) and median America Society of Anesthesiologists (ASA) score of 2 (range 1-3) were included. All patients underwent laryngo-tracheal surgery with median duration of 35 minutes (range 10-60 minutes) and median ventilation duration of 45 minutes (range 15-80 minutes). Surgical procedures included transoral laser microsurgery (TLM) (n=7), cordectomy (n=4), microlaryngoscopy for laryngeal bioexeresis (n=1), scar toilet after laryngeal TLM (n=1), exeresis of glottic synechia (n=1), and endoscopic supraglottic laryngectomy (n=1). All patients were successfully intubated with Tritube using videolaringoscopy, including several cases where severe subglottic/supraglottic stenoses had to be bypassed. FCV ventilation was titrated based on respiratory system compliance. No complications related to intubation, perioperative ventilation, or extubation occurred. In all patients, the small outer diameter of Tritube allowed an optimal accessibility and visualization of the surgical site, according to the surgeon in charge.

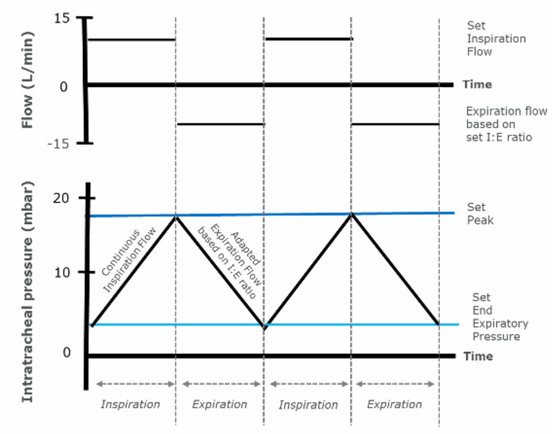
Discussion

In this series of 14 patients receiving FCV delivered via Tritube during laryngo-tracheal surgery, we observed that this strategy allowed maintaining adequate gas exchange, while providing optimal surgical exposure.

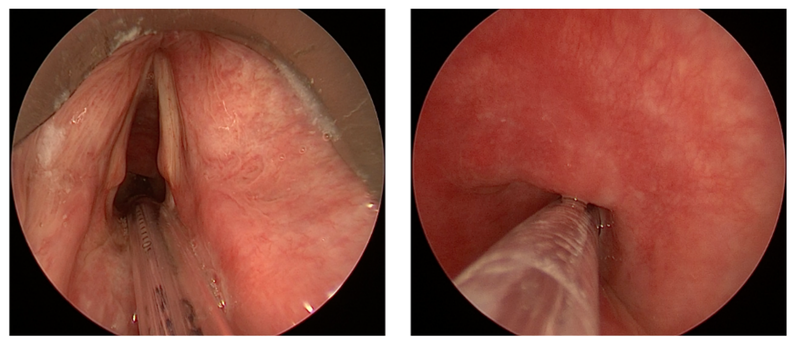
Patient	Tidal volume		Respiratory Rate	Peak pressure	EEP	Inspiratory Flow	Minute Volume	Resistance	Dynamic Compliance	Global Alveolar Driving Pressure	FiO2	Lower SpO2	Max etCO2
#	(mL/kg)	(mL)	(bpm)	(cmH2O)	(cmH2O)	(L/min)	(L/min)	(cmH2O/L/s)	(mL/cmH2O)	(cmH2O)		(%)	(mmHg)
1	6,2	409	14	12	5	12	5,7	5,1	53	5	0,25	99	35
2	5,9	320	16	17	5	10	5,1	12,0	25	8	0,30	94	36
3	6,7	410	18	30	1	15	7,4	12,5	13	23	0,30	88	45
4	4,1	270	22	18	7	12	5,9	16,2	21	5	0,30	92	43
5	6,0	430	14	15	5	12	6,0	12,8	36	5	0,30	96	39
6	6,7	440	12	14	5	10	5,3	7,4	46	7	0,30	94	45
7	6,7	490	13	15	5	12	6,4	7,6	44	7	0,30	95	45
8	6,7	380	16	16	5	12	6,1	8,6	32	8	0,30	96	42
9	6,4	447	15	16	5	12	6,7	8,0	37	8	0,25	96	39
10	7,5	528	13	15	5	13	6,9	6,5	47	7	0,25	96	41
11	6,2	427	17	19	6	13	7,3	10,5	27	8	0,25	93	38
12	7,1	480	11	16	5	11	5,3	6,5	41	9	0,25	90	38
13	6,2	458	14	13	5	12	6,4	5,9	52	6	0,25	96	38
14	7,6	387	9	17	8	7	3,5	10,5	49	7	0,25	96	35
Median	**6,6**	**429**	**14**	**16**	**5**	**12**	**6,1**	**8,3**	**39**	**7**	**0,28**	**96**	**39**
Lowest	**4,1**	**270**	**9**	**12**	**1**	**7**	**3,5**	**5,1**	**13**	**5**	**0,25**	**88**	**35**
Highest	**7,6**	**528**	**22**	**30**	**8**	**15**	**7,4**	**16,2**	**53**	**23**	**0,3**	**99**	**45**

Tritube: cuffed endotracheal tube with a length of 45 cm and outer diameter of 4.4 mm for adult patient ventilation in combination with FCV. Tritube has three lumens that allow 1) ventilation (2.3 mm inner diameter), 2) inflation and deflation of the cuff and 3) measurement of intratracheal pressures.





Setting Flow controlled Ventilation (FCV). Using FCV requires the setting of four parameters: 1) Inspiration flow, 2) I:E ratio, 3) Peak Pressure and 4) End-Expiratory Pressure (EEP). At the set flow rate gas is insufflated from set EEP until it reaches the set Peak pressure. Then the flow is reversed and gas is sucked out at the rate to reach the set I:E ratio until EEP is reached, aiming for a linear decrease in intratracheal pressure. Then a next insufflation with the set inspiration flow is started. Applied tidal volume results from the set driving pressure and respiratory system compliance.



Example: Videolaringoscopic view of a severe subglottic stenosis in patient scheduled for transoral laringeal microsurgery (TLM), intubated with Tritube. In the video the anesthesiologist gently rotates the tube to pass through the stenosis

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