Intravenous versus Inhalational Anaesthesia and Lung Ventilation-Perfusion Matching

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Background & Goal of Study: The efficiency of lung gas exchange deteriorates after induction of general anaesthesia due in part to increased ventilation-perfusion (V/Q) scatter.¹ Blood gas data from studies in the setting of one lung anaesthesia suggests that total IV anaesthesia (TIVA) with propofol may preserve V/Q matching better than inhalational agents.² We compared V/Q matching in patients under relaxant general anaesthesia randomized to either propofol TIVA or sevoflurane maintenance anaesthesia, using both Bohr deadspace and shunt fraction measurements and the MIGET (Multiple Inert Gas Elimination Technique) for characterization of V/Q distributions.³

Materials & Methods: Patients with clinical evidence of underlying lung disease were excluded. Baseline arterial blood sampling and collection of mixed expired gas was done before induction and repeated after 1-2 hours of relaxant general anaesthesia with controlled ventilation at an FiO₂ of 0.3, a target end-tidal PCO₂ of 30-35 mmHg and a bispectral index range of 40-60. Blood samples for MIGET were processed by headspace equilibration in 20mL gas tight glass syringes at 36°C, with measurement of partial pressures in expired and headspace gas samples by gas chromatography. The primary endpoint was comparison of the two groups in the change from preoperative in absolute difference between log standard deviation (δlogSD) of ventilation and blood flow distributions.

Data from 20 patients (10 in each group) was complete and deemed suitable for analysis.

Results & Discussion: There were no significant differences between the two groups in baseline demographics or lung function indices. Mean Bohr alveolar deadspace fraction (standard deviation SD) increased from baseline across both groups with anaesthesia [11.7 (9.1)% to 24.7 (4.8)%, $p < 0.001$) and the PaO₂/FIO₂ decreased [468 to 400 mmHg, log transformed $p = 0.023$], but shunt fraction (SD) was not significantly changed [13.1 (10.0)% to 10.5 (6.4)%, $p = 0.37$].

Primary endpoint: δlogSD (SD) was not different between TIVA and sevoflurane groups (0.17 (0.29) versus 0.17 (0.85), $p = 0.99$).

Variable (unit)	VD _{alv} /VT (%)		log PaO ₂ /FIO ₂		Q _s /Q _t (%)		Abs diff logSD	
	Sevo	TIVA	Sevo	TIVA	Sevo	TIVA	Sevo	TIVA
Preoperative mean (SD)	10.3 (7.0)	12.8 (10.7)	2.64 (0.07)	2.68 (0.08)	16.1 (9.9)	9.6 (9.1)	0.45 (0.60)	0.13 (0.14)
Intraoperative mean (SD)	25.0 (4.6)	25.0 (5.2)	2.59 (0.09)	2.59 (0.13)	11.0 (6.7)	10.0 (6.4)	0.62 (0.64)	0.30 (0.30)
δ (difference)	14.7	12.2	0.05	0.09	-5.1	0.4	0.17	0.17
[p value]	[< 0.001]	[0.005]	[0.039]	[0.015]	[0.233]	[0.879]	[0.515]	[0.097]
δδ (Sevo vs TIVA)	-2.5	0.04			5.5		0.0	
[p value]	[0.46]	[0.46]			[0.73]		[0.99]	

δ = difference between pre- and intraoperative, Sevo = sevoflurane, TIVA = propofol TIVA, VD_{alv}/VT = alveolar deadspace, Q_s/Q_t = shunt fraction, Abs diff logSD = absolute difference in log standard deviation (ventilation - blood flow)

Conclusions: We found no evidence that propofol TIVA better preserved V/Q matching in patients with normal lung function undergoing controlled ventilation compared with sevoflurane.

References:

1. Lumb AB. Nunn's Applied Respiratory Physiology, 5th edition. pp 421-59
2. Praetel, *et al.* Anesth Analg 2004;99:1107-13.
3. Roca J, Wagner PD. Thorax 1994 49: 815-824

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Figure 1: Pre-induction data from a patient in the sevoflurane group
logSD ventilation = 0.47, logSD blood flow = 0.45,
δlogSD = 0.02

Figure 2: Post-induction data from same patient in the sevoflurane group
logSD ventilation = 2.39, logSD blood flow = 0.69,
δlogSD = 1.70