Declarations of interest

UL received funding from an internal grant programme (project IFF 2020–26) of the Faculty of Health at Witten/Herdecke University, Witten, Germany, during the preparation of this work.

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doi: 10.1016/j.bja.2020.07.041
Advance Access Publication Date: 21 August 2020

Ventilator settings and arterial blood gases during video-assisted thoracoscopic surgery including pneumonectomy with pressure support ventilation

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Keywords: lung cancer; pneumonectomy; postoperative pulmonary complications; pressure support ventilation; thoracic anaesthesia; video-assisted thoracoscopic surgery

Editor—Lung cancer surgery is associated with a high rate of postoperative pulmonary complications including pneumonia, acute lung injury, and adult respiratory distress syndrome (ARDS).[1,2] It requires lung-protective ventilation strategies,[3,4] which include spontaneous ventilation video-assisted thoracoscopic surgery under general anaesthesia (SV-VATS).[5,6] During SV-VATS, patients in the lateral decubitus position breathe spontaneously with iatrogenic incomplete or subtotal lung collapse, and respiratory settings that allow for stable surgical access. Although advocated as protective for the lungs,[5,6] data on mechanical ventilator settings and resulting arterial blood gases during SV-VATS have not been reported. Such data constitute a prerequisite for evaluating the respiratory consequences of non-intubated spontaneous breathing patients during lung cancer surgery. Such data would also be necessary for the design of a prospective randomised trial comparing SV-VATS with standard management of thoracic surgical patients. Here we provide such data from anatomical lung resections including pneumonectomy in lung cancer patients.

During a 19 month period, 20 patients scheduled for video-assisted thoracoscopic surgery (VATS) for anatomical resection of lung cancer including left lower lobectomy (n=7), middle lobectomy (n=5), right lower lobectomy (n=5), lingula resection (n=1), lower bilobectomy (n=1), and pneumonectomy (n=1) were offered non-intubated pressure support ventilation (SV-VATS). All patients gave informed written consent in agreement with the ethical committee of the Bayerische Landesärztekammer (2020-1041) and Bavarian hospital law (BayKrG §27). Surgical and anaesthetic management followed expert consensus[6] and included EEG monitored target-controlled infusion of propofol and remifentanil, laryngeal mask airway, intrathoracic vagal blockade, and pressure support ventilation (Zeus and Perseus ventilator; Dräger, Lübeck, Germany). Settings of pressure support ventilation were chosen to guarantee lung protective tidal volumes with a maximum of 6–8 ml kg^{-1} (predicted body weight), adequate oxygenation, and sufficient space for surgical access. Patients had 16 and 18 gauge peripheral venous access and an arterial blood pressure catheter. Treatment was

Table 1 Patient characteristics, preoperative lung function testing, intraoperative ventilator settings, and results of intraoperative arterial blood gas analysis (n=20). DLCO, diffusing capacity of the lungs for carbon monoxide; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; TLC, total lung capacity; TV, tidal volume.

Preoperative data	Median	Range	Intraoperative data	Median	Range
Age (yr)	70	53–82	Respiratory rate	11	6.9–19
Height (cm)	164	154–185	TV (ml kg PBW−1)	4.6	2.9–7.3
Weight (kg)	68.5	48–84	PEEP (cm H_2O)	3.1	1.3–5.2
BMI (kg m^{-2})	24.2	19.8–31.2	ΔPsupp (cm H_2O)	2.4	0.5–9.8
Male (%)	25		Pmean PEEP (cm H_2O)	1.1	0.2–2.3
FVC (%)	90.9	68.8–132	PaO_2/FiO_2 (Horowitz index)	261	144–406
FEV1 (%)	91.7	61.6–132	$AaDO_2$ (kPa)	25.7	7.77–59.1
FEV1/FVC	0.79	0.64–0.97	$EtCO_2$ (kPa)	6.43	5.01–8.37
TLC (%)	101	75.8–144	$PaCO_2$ (kPa)	7.64	6.52–9.88
DLCO SB (%)	91.0	60.7–111	Base excess	−5.13	−8.5 to -1.25
PaO_2 (kPa)	10.2	8.73–12.4	pH	7.23	7.14–7.28
$PaCO_2$ (kPa)	4.68	3.33–5.29	Duration of surgery (min)	105	60–195

provided in all patients by physicians with more than 20 yr of clinical experience in lung cancer surgery (JB) and thoracic anaesthesia (PF) including VATS. Data are presented as median [range].

Patient characteristics, preoperative lung function tests, settings of pressure-support ventilation, and results of intraoperative arterial blood gas analyses are presented in Table 1. Blood gases were in the normal range after the operation (PaO_2: 12.6 [8.40–26.5] kPa; $PaCO_2$: 5.60 [4.37–6.13] kPa; BE: −3.15 [−6.2 to −0.5]; pH 7.35 [7.30–7.40]). Intraoperative cardiorespiratory complications were not observed. The median length of postoperative hospital stay was 4 (3–11) days.

Postoperative pulmonary complications are common after lung cancer surgery.[1–4] Lung-protective ventilation during single-lung ventilation using a double lumen tube is not always possible and adherence to lung protective ventilation strategies is incomplete.[3,4] SV-VATS has been advocated to reduce pulmonary complications after lung cancer surgery,[5,6] and to allow for faster postoperative recovery.[5,6]

Despite expert consensus on perioperative ventilation concepts,[6] intraoperative ventilator settings and resulting blood gases during SV-VATS have not been reported. Our case series provides such data for the first time for major lung cancer surgery. The data demonstrate that spontaneous breathing during anatomical resection for lung cancer surgery is feasible even during pneumonectomy with adequate oxygenation in all patients. The data also demonstrate the presence of hypercarbia and respiratory acidosis in all patients. Both were reversible immediately after the end of surgery when iatrogenic pneumothorax was reversed and delivery of anaesthetic agents had ended.

Permissive hypercarbia constitutes an established aspect of lung protective ventilatory strategies in critically ill patients.[7] Hypercarbia and respiratory acidosis with values similar to those observed in our case series have been shown to be beneficial during one-lung positive pressure ventilation with a double lumen tube.[8] Our case series demonstrates that SV-VATS allows lung protective tidal volumes, lung protective intrapulmonary pressures, and lung-protective intrapulmonary pressure gradients during anatomical resection for lung cancer surgery even during pneumonectomy lasting >3 h with moderate respiratory acidosis. These data constitute a prerequisite for the design of a prospective randomised trial comparing the outcome of SV-VATS to that of standard management of thoracic surgical patients.

Declaration of interests

The authors declare that they have no conflicts of interest.

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doi: 10.1016/j.bja.2020.08.002
Advance Access Publication Date: 25 August 2020