Abstract

OBJECTIVES: Re-expansion pulmonary oedema (RPO) sometimes occurs after minimally invasive cardiac surgery (MICS) with single-lung ventilation. However, it has not been widely recognized as a serious complication. The aim of this study is to evaluate the occurrence rate and risk factors of RPO.

METHODS: A total of 381 consecutive patients who underwent MICS with right mini-thoracotomy from March 2005 to October 2013 were retrospectively reviewed.

RESULTS: RPO was observed in 8 (2.1%) patients. In the preoperative data, greater percentages of preoperative use of steroid or immunosuppressant were found in patients with RPO (25% [2/8] vs 1% [4/373]; P = 0.0056). In the operative data, significantly longer operation, cardiopulmonary bypass (CPB) and aortic cross-clamping (ACC) times as well as greater percentages of second CPB run were found in patients with RPO (388 ± 80 vs 272 ± 61 min; P < 0.0002, 253 ± 79 vs 158 ± 50 min; P = 0.0009, 162 ± 65 vs 108 ± 38 min; P = 0.020 and 38% [3/8] vs 1.3% [5/373]; P < 0.0003). The overall 30-day mortality rate was 0.8% (3/381) and the 30-day mortality rate of patients with RPO was 12.5% (1/8). Significantly prolonged initial ventilation time, intensive care unit and postoperative hospital stay were observed in patients with RPO (P = 0.0022, <0.0001 and 0.0003, respectively). Multivariate logistic analysis detected preoperative use of steroid or immunosuppressant and prolonged ACC time (≥156 min) as independent risk factors for RPO after MICS (odds ratio [OR]: 87.6 [95% confidence interval, CI: 4.1–2463.8]; P = 0.006 and OR: 36.0 [95% CI: 4.8–731.4]; P < 0.001).

CONCLUSIONS: RPO should be recognized as one of the most serious complications after MICS with right mini-thoracotomy. More accurate risk factors of prolonged lung malperfusion and steroid use on RPO after MICS should be investigated.

Table 1: Comparison of preoperative patient demographics

	RPO ($n = 8$)	Non-RPO ($n = 373$)	*P*-value
Age (years)	52.4 ± 12.0	57.1 ± 14.85	0.247
Female gender	5 (63%)	149 (40%)	0.277
BSA (m^2)	1.65 ± 0.17	1.64 ± 0.19	0.707
DM	2 (25%)	32 (8.6%)	0.154
COPD	0 (0%)	11 (3%)	1.000
Smoking	2 (25%)	129 (35%)	0.720
LVEF (%)	59 ± 20	66 ± 10	0.220
Creatinine (mg/dl)	0.99 ± 0.6	0.92 ± 0.8	0.968
Steroid or immunosuppressant	2 (25%)	4 (1%)	0.006
ASD	0	27	
VSD	0	1	
Cardiac tumour	0	6	
AI	0	50	
AS	0	41	
MR	6	228	
MS	1	20	
Isolated TR	0	1	
AI + MR	1	4	
AS + MR	0	1	
AS + MS	0	2	

RPO: re-expansion pulmonary oedema; BSA: body surface area; DM: diabetes mellitus; COPD: chronic obstructive pulmonary disease; LVEF: left ventricular ejection fraction; ASD: atrial septal defect; VSD: ventricular septal defect; AI: aortic insufficiency; AS: aortic stenosis; MR: mitral regurgitation; MS: mitral stenosis; TR: tricuspid regurgitation.

Table 2: Comparison of perioperative data

	RPO (n = 8)	Non-RPO (n = 373)	P-value
Operation time (min)	388 ± 80	272 ± 61	<0.001
CPB time (min)	253 ± 79	158 ± 50	<0.001
ACC time (min)	162 ± 65	108 ± 38	0.020
Second pump run	3 (38%)	5 (1.3%)	<0.001
Initial ventilation time (h)	147.3 ± 241.6	8.3 ± 53.74	0.002
ICU stay (days)	9.5 ± 8.5	1.5 ± 0.9	<0.001
Hospital stay (days)	41.3 ± 21.0	20.3 ± 9.8	<0.001
30-day death	1 (12.5%)	2 (0.5%)	0.062

CPB: cardiopulmonary bypass; ACC: aortic cross-clamping; ICU: intensive care unit.

Table 3: Clinical characteristics of study patients

Patient	Gender	Age (years)	BSA (m^2)	Smoking	LVEF (%)	Immunosuppressant	Procedure	OP time	CPB time	Second run	Day of onset from surgery	Death
1	F	40	1.87	–	70	–	MVP + TAP	420	255	–	0	–
2	F	55	1.61	–	78	–	MVP	414	288	+	0	–
3	M	73	1.57	+	13	–	MVP	329	225	–	0	+
4	F	56	1.36	–	62	–	MVR + TAP	289	194	–	2	–
5	M	58	1.90	+	63	–	MVP + TAP	413	273	–	0	–
6	F	37	1.63	–	58	+	MVP	279	107	–	2	–
7	F	42	1.58	–	64	–	MVR	471	327	+	2	–
8	M	58	1.71	–	65	+	AVR + MVP	489	356	+	1	–
Mean ± SD		52 ± 12	1.65 ± 0.17		59 ± 20			388 ± 80	253 ± 79			

SD: standard deviation; BSA: body surface area; LVEF: left ventricular ejection fraction; MVP: mitral valve plasty; TAP: tricuspid annuloplasty; MVR: mitral valve replacement; AVR: aortic valve replacement; OP: operative; CPB: cardiopulmonary bypass.

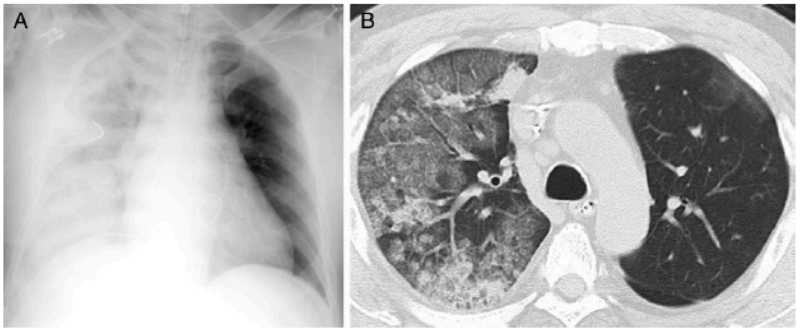

Figure 1: (**A**) Chest radiography of Case 1 shows a diffuse ground-glass attenuation of the right lung. (**B**) Chest computed tomography of Case 5 shows obvious unilateral change with alveolar consolidation and septal thickening.

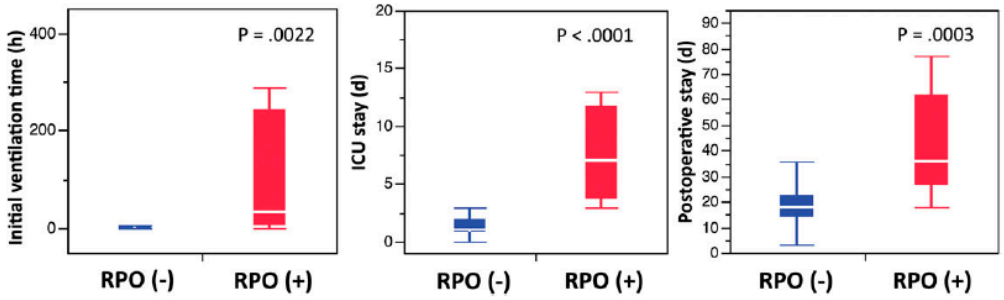

Figure 2: Comparison of postoperative data between patients with and without re-expansion pulmonary oedema (RPO). Significantly prolonged initial ventilation time, intensive care unit (ICU) and postoperative hospital stay were found in patients with RPO.