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ORIGINAL ARTICLE

Association of mechanical power and postoperative pulmonary complications among young children undergoing video-assisted thoracic surgery

A retrospective study

Change Zhu*, Rufang Zhang*, Jia Li, Lulu Ren, Zhiqing Gu, Rong Wei and Mazhong Zhang

BACKGROUND Previous studies have discussed the correlation between mechanical power (MP) and lung injury. However, evidence regarding the relationship between MP and postoperative pulmonary complications (PPCs) in children remains limited, specifically during one-lung ventilation (OLV).

OBJECTIVES Propensity score matching was employed to generate low MP and high MP groups to verify the relationship between MP and PPCs. Multivariable logistic regression was performed to identify risk factors of PPCs in young children undergoing video-assisted thoracic surgery (VATS).

DESIGN A retrospective study.

SETTING Single-site tertiary children's hospital.

PATIENTS Children aged ≤2 years who underwent VATS between January 2018 and February 2023.

INTERVENTIONS None.

MAIN OUTCOME MEASURES The incidence of PPCs.

RESULTS Overall, 581 (median age, 6 months [interquartile range: 5–9.24 months]) children were enrolled. The median [interquartile range] MP during OLV were 2.17 [1.84 to 2.64] $J\,min^{-1}$. One hundred and nine (18.76%) children developed PPCs. MP decreased modestly during the study period (2.63 to 1.99 $J\,min^{-1}$; $P < 0.0001$). In the propensity score matched cohort for MP (221 matched pairs), MP (median MP 2.63 vs. 1.84 $J\,min^{-1}$) was not associated with a reduction in PPCs (adjusted odds ratio, 1.43; 95% CI, 0.87 to 2.37; $P = 0.16$). In the propensity score matched cohort for dynamic components of MP (139 matched pairs), dynamic components (mean 2.848 vs. 4.162 $J\,min^{-1}$) was not associated with a reduction in PPCs (adjusted odds ratio, 1.62; 95% CI, 0.85 to 3.10; $P = 0.15$).

The multiple logistic analysis revealed PPCs within 7 days of surgery were associated with male gender, OLV duration >90 min, less surgeon's experience and lower positive end-expiratory pressure (PEEP) value.

CONCLUSIONS MP and dynamic components were not associated with PPCs in young children undergoing VATS, whereas PPCs were associated with male gender, OLV duration >90 min, less surgeon's experience and lower PEEP value.

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KEY POINTS

- Question: is mechanical power associated with postoperative pulmonary complications (PPCs) in children requiring one-lung ventilation (OLV) for video-assisted thoracic surgery?
- Findings: in this study, mechanical power and dynamic components were not statistically associated with a greater risk of PPCs within the first 7 postoperative days in young children undergoing OLV. PPCs were associated with male gender, OLV duration >90 min, less surgeon's experience and lower positive end-expiratory pressure value.
- Conclusion: Our findings may serve as targets for future prospective interventional studies investigating the impact of specific ventilation strategies on postoperative outcomes in children.

Introduction

Patients who undergo lung resection are at risk of experiencing ventilator-induced lung injury, as well as direct surgical injury, contributing to an increased risk of postoperative pulmonary complications (PPCs).[1] Previous studies have primarily focused on intra-operative lung protective ventilation (LPV) to minimise tidal volume and overdistension. However, despite the strict limitations on tidal volume and the application of positive end-expiratory pressure (PEEP), there was no significant decrease in the prevalence of PPCs following lung resection.[2] Current recommendations for protective ventilation focus primarily on minimal driving pressure as a key factor in reducing the incidence of PPCs.[3,4] However, recent prospective trials revealed that driving pressure guided ventilation did not decrease the incidence of PPCs when compared to conventional protective ventilation in thoracic surgery.[5,6]

Mechanical power (MP) is a newly introduced notion of mechanical ventilation, which assesses the amount of energy transmitted to lungs during mechanical ventilation, quantified in joules per minute.[7,8] The concept of MP incorporates tidal volume, driving pressure, and respiratory rate (RR). A higher MP was associated with increased mortality in patients with acute respiratory distress syndrome (ARDS).[9] In addition, recent large clinical trial demonstrated MP was associated with a higher risk of postoperative respiratory failure (PRF) in patients receiving general anaesthesia[8] and patients receiving one-lung ventilation (OLV).[10] However, the relationship between the intensity of ventilation during OLV in children and clinical outcomes remains unclear.

The primary aim of this study was to examine the relationship between MP (or dynamic components of MP) during OLV with the development of PPCs in young children undergoing video-assisted thoracic surgery (VATS). The secondary aims were to identify risk factors of PPCs in young children undergoing VATS.

Patients and methods

Study design

This retrospective cohort study analysed data from surgical cases performed between January 2018 and February 2023 at one academic hospital: Shanghai Children's Hospital, Shanghai Jiao Tong University School of Medicine. The study was approved by the research ethics board of Shanghai Children's Hospital, Shanghai, China (Prof. Bing Lu, chairperson) on 25 July 2023 (approval number: 2021R129-E03). The trial was registered at chictr.org.cn (trial number: ChiCTR2300074649). The requirement for written informed consent was waived by the institutional review board.

Data collection

We collected the following data: baseline characteristics, including sex, age, body weight, and height; type of surgical procedure; intraoperative respiratory parameters; end-tidal carbon dioxide ($EtCO_2$); oxygen saturation levels (SpO_2); blood gas analysis; OLV duration; postoperative laboratory and imaging data; and vital signs. The data, including minute-by-minute recordings of ventilator parameters, were extracted from the patients' electronic medical records. A data analysis and statistical plan was established before the data were accessed.

Inclusion and exclusion criteria

Children younger than 2 years old with an American Society of Anesthesiologists physical status (ASA) of 1–2 who underwent video-assisted thoracoscopic lung resection secondary to either congenital pulmonary airway malformation (CPAM) or pulmonary sequestration with available electronic documentation were evaluated for inclusion in this study. Patients with incomplete data were excluded.

Measurements

The focus of interest in this study was characterised by data on the MP and dynamic components of MP during intraoperative ventilation, estimated by different variables, including the tidal volume (Vt), RR, PEEP, plateau pressure (Pplat), and peak airway pressure (Ppeak). The MP was calculated using a simplified formula as follows: $MP\ (J\ min^{-1}) = 0.098 * RR * Vt * (PEEP + \frac{1}{2}[Pplat - PEEP] + [Ppeak - Pplat])$.[10–12] Consequently, the MP was calculated by multiplying the work of breathing for every breath by the RR.[13] The MP was calculated as $MP = 0.098 * RR * Vt * (\frac{1}{2}Pplat + \frac{1}{2}PEEP)$ in pressure-controlled ventilation mode. The dynamic components of MP were calculated as $0.098 * RR * Vt * (Ppeak - PEEP)$.[11]

Definition of postoperative pulmonary complications

The primary outcome was PPCs, defined as any of the following conditions: initial ventilator support for >48 h, reintubation, pneumonia, atelectasis requiring bronchoscopy, ARDS, air leakage for >5 days, bronchopleural fistula, respiratory failure, tracheostomy, pulmonary embolism, or empyema requiring treatment.[2] Suspected respiratory tract infection was defined as infections requiring antibiotics and one or more of the following criteria: new or altered sputum, new or altered lung opacification, fever, and/or white blood cell count >12 $\times 10^9$ l^{-1}.[2]

Primary analysis

In the primary analysis, we assessed the association between intraoperative mechanical power and PPCs within 7 days after surgery using propensity score matching analysis.

Secondary analyses

In secondary analyses, we performed analysis of risk factors of PPCs in young children undergoing VATS.

Statistical analyses

The data are presented as *n* (%) for categorical variables, the mean with standard deviation (SD) for normally distributed continuous variables, and the median (interquartile range) for non-normally distributed continuous variables. To compare continuous variables between the study groups, Student's *t*-test was used for normally distributed data, while the Mann–Whitney *U* test was used for nonnormally distributed data. The normality of the data was evaluated using the Shapiro–Wilk test. For categorical variables, the χ^2 test or Fisher's exact test was used.

Patients were divided into high vs. low MP groups based on the mean or median MP. Propensity score matching (PSM) was used to generate the low and high MP groups with comparable characteristics. All patient and surgical characteristics were compared between the low and high MP groups using the chi-squared test or Mann–Whitney *U* test. We performed 1 : 1 greedy nearest neighbour matching, and calliper widths were determined by decreasing the computed optimal caliper widths until the criterion of balance, that is, the absolute standardised mean difference between the two groups < 0.1.[14] Univariable analyses were performed on the matched sets using the Wilcoxon signed rank test for paired continuous variables and the McNemar exact test or the marginal homogeneity exact test for categorical variables. The incidence of PPCs was compared between the propensity score-matched low and high MP groups using conditional exact logistic models. The odds of PPCs for the high and low MP groups were characterised by the odds ratio (OR) from the exact logistic regression models.

To verify the relationship between dynamic components of MP and PPCs, we performed secondary propensity score matching analysis.

The analysis of risk factors was performed in the following sequence. First, the unadjusted relationship between exposures and outcome was determined by univariate logistic regression. Second, the confounder adjusted relationship between variables and outcome was determined by multivariable logistic regression. The presence of multicollinearity among related parameters was evaluated using the variance inflation factor >2.5. In cases where multicollinearity was detected among variables, one variable was selected based on its clinical significance. Continuous confounders were categorised into clinically relevant categories. The following risk predictors were adjusted for regression models: age, sex, American society of Anesthesiologists (ASA) status, type of operation (lobectomy, segment, or isolated lung resection), surgical side (left or right), OLV duration, respiratory rate, low tidal volume ventilation, primary surgeon's surgical experience, driving pressure, and MP or dynamic components of MP. In the present study, low tidal volume during OLV was defined as an exhaled tidal volume of ≤6 ml kg^{-1} of weight. The cut-off of 6 ml kg^{-1} was based on data that were already available when the study was designed.[15] However, the optimal goal of low tidal volume ventilation in children undergoing OLV has not yet been established. Unlike the recommended tidal volume for OLV of ≤4–6 ml/kg in adults,[16] a tidal volume <6 ml kg^{-1} in paediatric patients poses a risk of hypercapnia, especially for young children. Therefore, to ensure our findings was not affected by the cut-off of low tidal volume, we performed a secondary analysis using a redefined low tidal volume of <8 ml kg^{-1}.

All statistical analyses were performed using R software, version 4.2.2, and the MatchIt package, along with the use of MSTATA software.

Results

Study cohort and characteristics

After implementing the exclusion criteria and removing cases with missing confounder information, our final study cohort comprised a total of 581 patients, median age 5.9 months (interquartile range 4.8 to 7.9 months and range 3 months to 2 years). The median [interquartile range] MP and mean (standard deviation) dynamic components of MP during OLV were 2.17 [1.84 to 2.64) J min^{-1} and 3.44 ± 1.2 J min^{-1}, respectively.

Characteristics of anaesthetic management

Upon arrival in the operating room, routine monitoring, including blood pressure, heart rate, electrocardiogram, and oxygen saturation, was performed using an anaesthesia monitor. A standardised general anaesthetic protocol was administered to all patients, including preoxygenation and rapid sequence induction including intravenous administration of sufentanil, propofol, and either rocuronium or cisatracurium. OLV was achieved through the placement of an extraluminal bronchial blocker (Hangzhou Tanpa Medical Technology, Hangzhou, Zhejiang, China) using a fibreoptic bronchoscope. Invasive arterial access was obtained after the completion of endotracheal intubation. Pressure-controlled volume-guaranteed ventilation was employed, with the aim to achieve the desired tidal volume. The lungs were manually re-expanded with sustained inflation, applying PEEP of 30–35 cm H_2O for 10–15 s under direct observation to restore two-lung ventilation (TLV) at the end of OLV. Crystalloid solutions were administered as maintenance fluids at a rate of <8 ml kg^{-1} h^{-1}.

At the end of the surgery, a single experienced attending anaesthesiologist performed unilateral erector spinae plane block with 0.2% to 0.25% ropivacaine injected into the target interfacial plane. Additionally, all patients received patient-controlled intravenous analgesia (PCIA) with sufentanil. The PCIA pump (REHN11, Renxian Medical Corporation, Jiangsu, China) was set to deliver a background infusion of sufentanil 0.02 μg kg^{-1} h^{-1}. The young children undergoing VATS were routinely transferred to the cardiac care unit for weaning. The weaning criteria include hemodynamic stability, adequate level of consciousness, spontaneous respiratory effort and SPO_2 >96% when breathing air.

Primary outcome

Among the 581 patients, 109 (18.76%) developed one or more PPCs. The most common PPCs was PRF, which was observed in 64 patients (11.02%). The second was pneumonia, which was observed in 31 patients (5.34%). Air leakage over 5 days occurred in 11 patients (1.89%), while one patient (0.17%) suffered from atelectasis that required bronchoscopy. One patient (0.17%) was diagnosed with bronchopleural fistula, and another (0.17%) required initial mechanical ventilation for >48 h.

Primary aim: the relationship between mechanical power or dynamic components of mechanical power and postoperative pulmonary complications

In 2018, median [IQR] MP was 2.63 [2.3, 3.05] J min^{-1}; in 2023, median [IQR] MP was 1.99 [1.76, 2.31] J min^{-1} ($P < 0.0001$), and mean dynamic components of MP was 2.65 ± 0.67 J min^{-1} in 2018 and 1.86 ± 0.33 J min^{-1} in 2023 ($P < 0.001$; Fig. 1).

The median intraoperative MP was 2.22 [IQR 1.84, 2.64] J min^{-1} and mean dynamic components of MP was 3.446 $\pm$ 1.198 J min^{-1}. We divided patients into high vs. low MP (or dynamic components of MP) groups based on the median intraoperative MP (or mean dynamic components of MP). A notable reduction in SMDs after matching can be observed, indicating that the propensity score matching effectively improved the balance of covariates between the two treatment groups (Table 1, Fig. 2). 221 high MP cases were propensity score–matched to 221 low MP cases, resulting in a primary aim study population of 442 patients. The result of conditional logistic models revealed that the MP (median MP 2.63 vs. 1.84 J min^{-1}) was not associated with a reduction in PPCs (adjusted odds ratio, 1.43; 95% CI, 0.87 to 2.37; $P = 0.16$) (Table 2).

One hundred and thirty-nine high dynamic components of MP cases were propensity score–matched to 139 low dynamic components of MP cases, resulting in a primary aim study population of 278 patients (Table S1, Supplemental Digital Content, http://links.lww.com/EJA/B42, Fig. S1, Supplemental Digital Content, http://links.lww.com/EJA/B42). The result of conditional logistic models revealed that dynamic components of MP (mean 2.848 vs. 4.162 J min^{-1}) were not associated with a reduction in PPCs (adjusted odds ratio, 1.62; 95% CI, 0.85 to 3.10; $P = 0.15$).

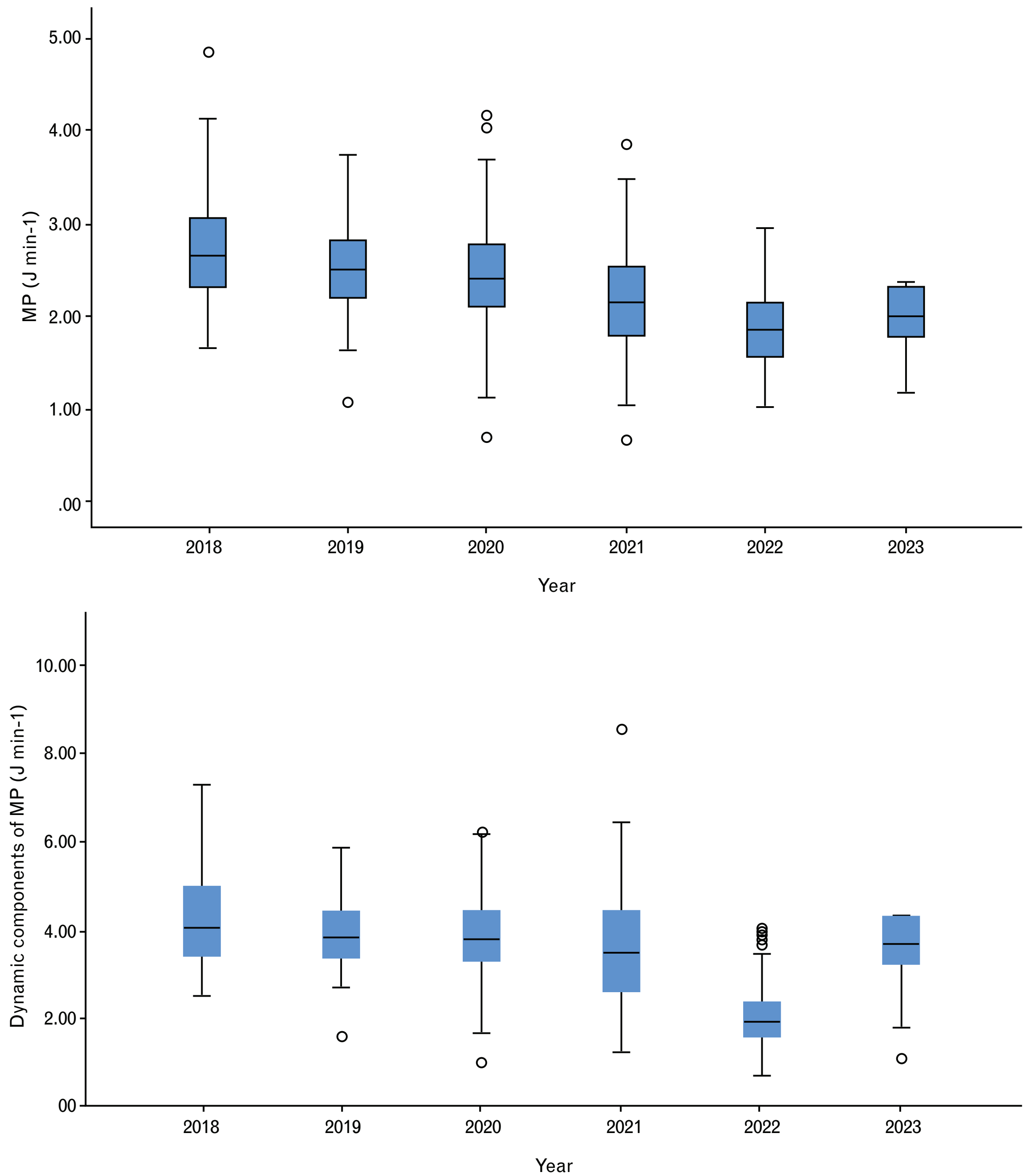
Secondary aim: risk factors of postoperative pulmonary complications for young children undergoing video-assisted thoracic surgery

Given the lack of association between MP and PPCs, we attempted to derive risk factors associated with PPCs. All presented *P* values and OR were adjusted for the following risk predictors: age, sex, ASA, operation type (lobectomy, segment or isolated lung resection), operation side (left or right), OLV duration, PEEP value, MP during OLV, RR during TLV, peak airway pressure, low tidal volume ventilation, less surgeon's experience and estimated blood loss. OLV duration was categorised into clinically relevant category as OLV duration over 90 min. Among these possible risk factors, male gender (OR, 2.2; 95% CI, 1.37 to 3.65; $P = 0.002$), OLV duration over 90 min (OR, 1.62; 95% CI, 1.01 to 2.62; $P = 0.048$), and less surgeon's experience (OR, 1.78; 95% CI, 1.06 to 2.99; $P = 0.027$) were associated with PPCs within 7 days of surgery (Table 3, Fig. 3).

To ensure our findings were not affected by the cut-off of low tidal volume, we performed a secondary analysis using a redefined low tidal volume of <8 ml kg^{-1}. The multivariate analysis revealed that male gender (OR, 2.16; 95% CI, 1.34 to 3.57; $P = 0.002$), PEEP value (OR, 0.83; 95% CI, 0.7 to 0.98; $P = 0.025$), and less surgeon's experience (OR, 1.83; 95% CI, 1.09 to 3.07; $P = 0.021$) were associated with PPCs within 7 days of surgery (Fig. S2, Supplemental Digital Content, http://links.lww.com/EJA/B42)

Due to the collinearity between MP and dynamic components of MP, we performed the secondary analysis when the dynamic component of MP was adjusted for regression models. The multivariable analysis revealed that male gender, OLV duration over 90 min, and less surgeon's experience were associated with PPCs within 7 days of surgery. (Fig. S3, Supplemental Digital

Fig. 1 Mechanical power over time by study year. MP, mechanical power.



Content, http://links.lww.com/EJA/B42, Fig. S4, Supplemental Digital Content, http://links.lww.com/EJA/B42)

Discussion

In this retrospective cohort trial of young children undergoing lung resection surgery, MP and dynamic components of MP during intraoperative mechanical ventilation were not statistically associated with a greater risk of PPCs within the first 7 postoperative days. PPCs were associated with male gender, OLV duration >90 min, less surgeon's experience and lower PEEP value.

MP decreased over the 5 year study period owing to increasing adoption of the low-tidal-volume ventilation and permissive hypercapnia strategy. Our study demonstrated that MP was not statistically associated with a greater risk of PPCs. Although many retrospective and observational studies have shown a close relationship

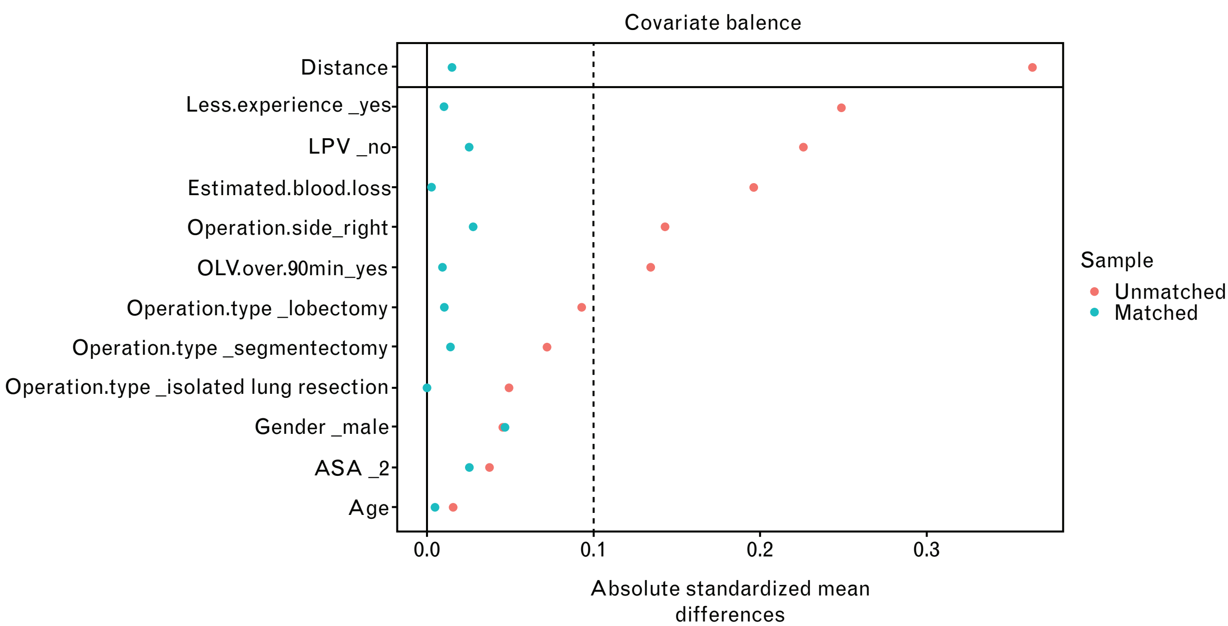
Table 1 Characteristics of patients before and after propensity score matching by MP status (high MP vs. low MP)

Variables	Level	Before matching			After matching		
		Low MP group	High MP group	SMD	Low MP group	High MP group	SMD
n		291	290		221	221	
Age (mean (SD))		7.67 (4.31)	7.59 (4.69)	−0.015	7.44 (4.31)	7.42 (4.65)	−0.004
Sex (%)	Female	104 (35.7)	110 (37.9)	0.045	81 (36.7)	76 (34.4)	−0.047
	Male	187 (64.3)	180 (62.1)	−0.045	140 (63.3)	145 (65.6)	0.047
ASA (%)	1	48 (16.5)	44 (15.2)	−0.037	36 (16.3)	38 (17.2)	0.025
	2	243 (83.5)	246 (84.8)	0.037	185 (83.7)	183 (82.8)	−0.025
Operation type (%)	Isolated lung resection	44 (15.1)	39 (13.4)	−0.049	34 (15.4)	34 (15.4)	0.000
	Segmentectomy	43 (14.8)	36 (12.4)	−0.072	31 (14.0)	30 (13.6)	−0.014
	Lobectomy	204 (70.1)	215 (74.1)	0.092	156 (70.6)	157 (71.0)	0.010
Operation side (%)	Left	145 (49.8)	165 (56.9)	0.143	117 (52.9)	120 (54.3)	0.027
	Right	146 (50.2)	125 (43.1)	−0.143	104 (47.1)	101 (45.7)	−0.027
OLV over 90 min (%)	No	169 (58.1)	149 (51.4)	−0.134	125 (56.6)	124 (56.1)	−0.009
	Yes	122 (41.9)	141 (48.6)	0.134	96 (43.4)	97 (43.9)	0.009
Less experience (%)	No	225 (77.3)	190 (65.5)	−0.248	168 (76.0)	167 (75.6)	−0.010
	Yes	66 (22.7)	100 (34.5)	0.248	53 (24.0)	54 (24.4)	0.010
LPV (%)	Yes	69 (23.7)	45 (15.5)	−0.226	42 (19.0)	40 (18.1)	−0.025
	No	222 (76.3)	245 (84.5)	0.226	179 (81.0)	181 (81.9)	0.025
Estimated blood loss (mean (SD))		13.61 (5.10)	14.71 (5.61)	0.196	13.56 (4.90)	13.54 (4.45)	−0.002

ASA, American Society of Anesthesiologists physical status; LPV, lung protective ventilation; MP, mechanical power; OLV, one lung ventilation; SD, standard deviation; SMD, standardised mean difference.

between high MP and morbidity/mortality rates [7,8,17–19] and suggested driving pressure as a new ventilation target,[4,20] the impact of MP on clinical outcomes have been evaluated only in retrospective trials. In a previous thoracic surgery study, a higher intensity of OLV, mainly driven by driving pressure, was dose-dependently associated with PRF.[10] The different findings from our current paediatric study may be due to methodological and surgical differences. This earlier trial examined a more objective and a lower incidence outcome based on PRF, and studied a more heterogeneous surgical population,[10] while our present study focused on PPCs and CPAM patients less than 2 years old. Moreover, it remains unclear whether high MP is a consequence of

Fig. 2 Absolute standardised mean differences between low MP and high MP groups before and after matching for 11 variables included in the calculation of propensity scores among young children undergoing VATS.



ASMD less than 0.10 indicates a balance between the 2 groups. ASA, American society of Anesthesiologists status; ASMD, absolute standardised mean difference; LPV, lung protective ventilation; MP, mechanical power; OLV, one lung ventilation.

Table 2 Conditional logistic regression for effectiveness analysis (unmatched vs. matched data)

Characteristic	OR	95% CI	*P*-value
Treatment (unmatched)			
low MP group	–	–	
high MP group	1.29	0.85, 1.96	0.24
Treatment (matched)			
low MP group	–	–	
high MP group	1.43	0.87, 2.37	0.16

CI, confidence interval; MP, mechanical power; OR, odds ratio.

preexisting lung injury or that high MP itself is a cause of lung injury. This subtle confounding factor is difficult to extract retrospectively from the clinical records.

Our present study adds to previous research evaluating the association between PPCs and MP after pulmonary resection.[18] This previous study concluded that time-weighted average MP and total mechanical energy were independently associated with PPCs in thoracic surgery.[18] However, the duration of mechanical ventilation was not adjusted as a risk predictor for regression models. In contrast, our study demonstrated that OLV duration was a significant risk factor of PPCs.

The present study indicates that the difference in RRs between the PPC and non-PPC groups was relatively small. It was a key point to consider when interpreting our findings because driving pressure and RR are core components of MP. In previous studies, driving pressure was decreased by 1.8 cmH_2O or more through intervention,[5,21] but in our study the difference in driving pressure between the PPCs and non-PPCs groups was relatively small. In patients receiving mechanical ventilation during major surgery, a higher MP has been found to be significantly associated with the development of PPCs[7,18,19] and PRF [8,10] and driving pressure is a relevant potential mediator on the effect of ventilation on outcomes in these patients.[7] However, previous retrospective studies have failed to identify a significant relationship between PPCs and either driving pressure[21] or modified driving pressure (peak pressure minus PEEP) [2] after thoracic surgery. Moreover, driving pressure may not accurately reflect transpulmonary driving pressure, which holds greater physiological significance for alveolar mechanics and lung injury.[22]

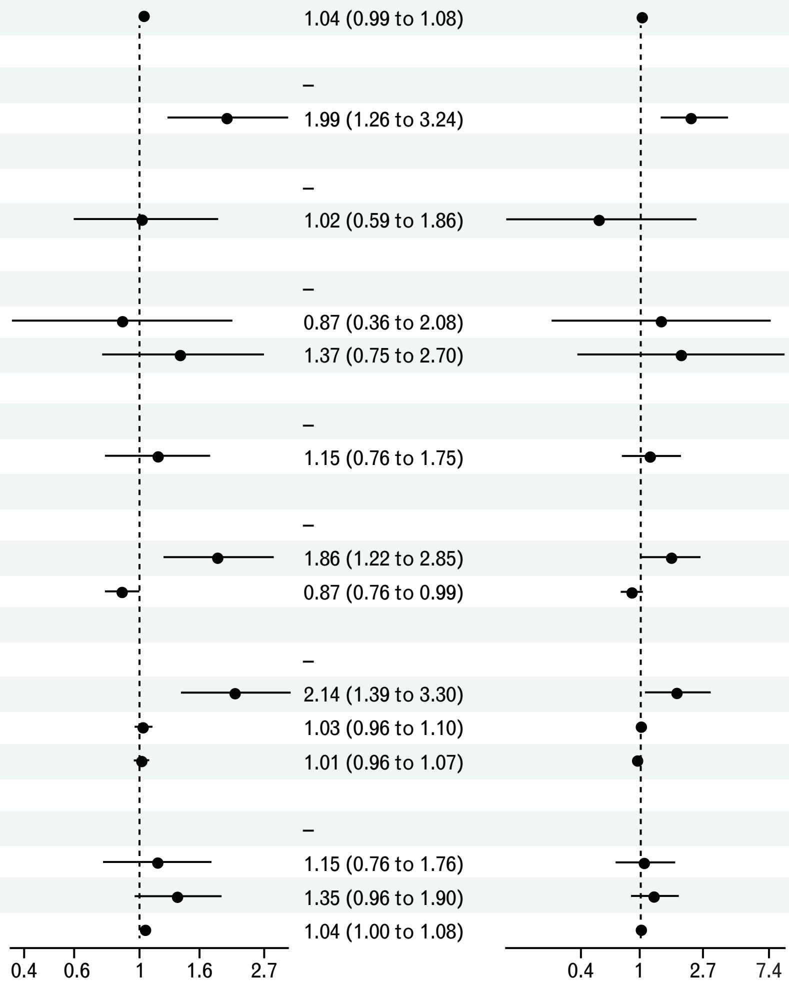
Our study indicates that PEEP can be beneficial in reducing PPCs during OLV in paediatric patients. However, there is currently no established guideline for determining the appropriate PEEP value for children undergoing OLV. In our study, we found that lower PEEP value was independently associated with PPCs. Indeed, it is reasonable to assume that a CO_2 inflation pressure of 5–7 cmH_2O in the operative lung may transmit to the ventilatory side; thus, the alveoli on the ventilatory side of the lung during the expiratory phase

Table 3 Univariate and multivariate analysis of risk factors of PPCs for young children undergoing VATS (LTV < 6 ml kg^{-1})

Characteristic	Univariable *N*	Event *N*	OR	95% CI	*P*-value	Multivariable *N*	Event *N*	OR	95% CI	*P*-value
Age (months)	581	109	1.04	0.99, 1.08	0.092	581	109	1.02	0.97, 1.08	0.399
Sex										
Female	214	27	—	—		214	27	—	—	
Male	367	82	1.99	1.26, 3.24	0.004	367	82	2.20	1.37, 3.65	0.002
ASA										
1	92	17	—	—		92	17	—	—	
2	489	92	1.02	0.59, 1.86	0.940	489	92	0.53	0.12, 2.39	0.389
Operation type										
Isolated lung resection	83	13	—	—		83	13	—	—	
Segmentectomy	79	11	0.87	0.36, 2.08	0.756	79	11	1.41	0.24, 7.76	0.694
Lobectomy	419	85	1.37	0.75, 2.70	0.333	419	85	1.91	0.37, 9.44	0.422
Operation side										
Left	310	55	—	—		310	55	—	—	
Right	271	54	1.15	0.76, 1.75	0.501	271	54	1.18	0.75, 1.84	0.468
OLV over 90 min										
No	318	46	—	—		318	46	—	—	
Yes	263	63	1.86	1.22, 2.85	0.004	263	63	1.62	1.01, 2.62	0.048
PEEP value (cmH_2O)	581	109	0.87	0.76, 0.99	0.040	581	109	0.88	0.75, 1.03	0.120
Less experience										
No	415	63	—	—		415	63	—	—	
Yes	166	46	2.14	1.39, 3.30	<0.001	166	46	1.78	1.06, 2.99	0.027
RR (min^{-1})	581	109	1.03	0.96, 1.10	0.403	581	109	1.02	0.95, 1.09	0.574
Peak (cmH_2O)	581	109	1.01	0.96, 1.07	0.695	581	109	0.97	0.90, 1.04	0.387
Low tidal volume										
Yes	267	47	—	—		267	47	—	—	
No	314	62	1.15	0.76, 1.76	0.510	314	62	1.08	0.68, 1.73	0.753
MP (J min^{-1})	581	109	1.35	0.96, 1.90	0.087	581	109	1.25	0.87, 1.80	0.230
Estimated blood loss (ml)	581	109	1.04	1.00, 1.08	0.027	581	109	1.02	0.97, 1.06	0.468

ASA, American Society of Anesthesiologists status; CI, confidence interval; MP, mechanical power; OLV, one lung ventilation; OR, odds ratio; Peak, peak airway pressure; PEEP, positive end-expiratory pressure; RR, respiratory rate.

Fig. 3 Forest figure of risk factors for young children undergoing VATS.



Characteristics	OR (95% CI)	Adjusted OR (95% CI)
Age	1.04 (0.99 to 1.08)	1.02 (0.97 to 1.08)
Gender		
Female	–	–
Male	1.99 (1.26 to 3.24)	2.20 (1.37 to 3.65)
ASA		
1	–	–
2	1.02 (0.59 to 1.86)	0.53 (0.12 to 2.39)
Operation type		
Isolated lung resection	–	–
Segmentectomy	0.87 (0.36 to 2.08)	1.41 (0.24 to 7.76)
Lobectomy	1.37 (0.75 to 2.70)	1.91 (0.37 to 9.44)
Operation side		
Left	–	–
Right	1.15 (0.76 to 1.75)	1.18 (0.75 to 1.84)
OLV over 90 min		
No	–	–
Yes	1.86 (1.22 to 2.85)	1.62 (1.01 to 2.62)
PEEP value	0.87 (0.76 to 0.99)	0.88 (0.75 to 1.03)
Less experience		
No	–	–
Yes	2.14 (1.39 to 3.30)	1.78 (1.06 to 2.99)
RR	1.03 (0.96 to 1.10)	1.02 (0.95 to 1.09)
Peak	1.01 (0.96 to 1.07)	0.97 (0.90 to 1.04)
Low tidal volume		
Yes	–	–
No	1.15 (0.76 to 1.76)	1.08 (0.68 to 1.73)
MP	1.35 (0.96 to 1.90)	1.25 (0.87 to 1.80)
Estimated blood loss	1.04 (1.00 to 1.08)	1.02 (0.97 to 1.06)

ASA, American Society of Anesthesiologists status; CI, confidence interval; MP, mechanical power; OLV, one lung ventilation; OR, odds ratio; Peak, peak airway pressure; PEEP, positive end-expiratory pressure; RR, respiratory rate; VATS, video-assisted thoracic surgery.

are more likely to collapse when the PEEP level is lower than the intrathoracic pressure.[23] Interestingly, the present study demonstrated male gender was found to be a risk factor for PPCs, and this finding was consistent with previous studies on adults.[24–26] However, data on children is lacking and the reason for the high incidence of PPCs in boys remains unknown. Additionally, postoperative complications were associated the surgeon's experience, which was consistent with previous studies.[27,28]

To our knowledge, this was the first study to investigate the association between MP and PPCs in children requiring OLV. However, this study has several limitations. First limitation arises from the retrospective study design, wherein sample selection was constrained by data availability and confounding factors. Second, the single site nature of the study may impact the generalisability of the results. Finally, it is important to interpret our results with caution because intentional crystalloid restriction during surgery and maintaining peak airway pressure below 30 cmH_2O was a routine practice in our facility.

In conclusion, high MP does not appear to be associated with PPCs among young children undergoing thoracoscopic lung resection. PPCs were associated with male gender, OLV duration >90 min, less surgeon's experience and PEEP value. Further studies on MP in high-risk patients and in other surgical populations is warranted.

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