Application of driving-pressure-oriented mechanical ventilation in elderly patients undergoing posterior lumbar fusion surgery: a Pilot Feasibility Study

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Abstract

Background: *Elderly patients undergoing posterior lumbar fusion surgery under general anesthesia are at increased risk of postoperative pulmonary complications (PPCs) due to decreased respiratory physiology. Driving pressure in mechanical ventilation is highly associated with occurrence of PPCs. Therefore, driving pressure-oriented ventilation strategy has attracted great attention. To explore the effects of driving pressure-oriented mechanical ventilation on occurrence rate of PPCs in elderly patients undergoing posterior lumbar interbody fusion, we conducted a pilot study in advance to confirm its safety and feasibility.*

Methods :*The pilot study was prepared to enroll 160 patients for eligibility assessment. Initially, elderly patients undergoing posterior lumbar interbody fusion were randomly divided into two groups: Group P and group C. Treatment of patients in Group P involved the use of driving pressure-oriented mechanical ventilation while conventional lung protective ventilation strategy was used for patients in Group C. Then, the perioperative ventilation and hemodynamic and blood oxygenation were determined.*

Results: *The minimum driving pressures for Groups C and P were 8.79±1.44 and 7.47±1.17 cm H2O, respectively ($p<0.05$). Partial pressure for oxygen and oxygenation index for Group P at 20 min before the end of the surgery were significantly higher than those of Group C($p<0.05$).The incidences of postextubation hypoxemia for Groups C and P were 11.7% and 9.9%, respectively ($p>0.05$).*

Conclusions: *Driving pressure-oriented mechanical ventilation improved intraoperative arterial oxygenation in elderly patients undergoing posterior lumbar fusion, but the incidence of postextubation hypoxemia was not affected.*

Trial registration:*This pilot study is registered at www.medresman.org (ChiCTR2100054078), and the date of first registration was 08/12/2021 .*

INTRADUCTION

Lumbar degenerative diseases, including lumbar disc herniation, lumbar spinal stenosis, and lumbar spondylolisthesis seriously affect the quality of life of patients, with age or long-term overload activities. Posterior lumbar interbody fusion is the main treatment option for improving the quality of life for patients. It has been reported[1] that the number of elderly patients who undergo posterior lumbar interbody fusion has significantly increased. With increasing age, there is a decrease in physiological and pulmonary functions, companied by weak strength of respiratory muscles. Moreover, with mechanical ventilation under general anesthesia and lung injury-related factors, the incidences of postoperative pulmonary complications (PPCs) in elderly patients who undergo posterior lumbar interbody fusion has markedly increased. Clinically, PPCs are among the major causes of prolonged hospital stay, which increases the hospitalization costs and poses a great threat to the life and health of patients[2,3]. reduce the incidences of PPCs. Applications of LPVS involves low tidal volumes, positive end-

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expiratory pressures (PEEP) and lung recruitment maneuvers (RM). A previous multicenter study[5] investigated the incidences of PPCs in patients undergoing non-cardiothoracic surgery. It was found that the lung protective effects of low tidal volume are relative to the ventilation strategy of high VT, which is not entirely equivalent to lung protection. During positive pressure ventilation, high driving pressure is a critical indicator of lung injury, and is closely correlated with the occurrence of PPCs. Outcomes from an individualized mechanical ventilation strategy suggested that the VT of initial mechanical ventilation should be set at 6-8 mL/kg in ideal weight combined with 5 cm H2O PEEP, followed by setting PEEP according to individual differences[6]. The individualized PEEP measured by driving pressure is one of the main methods.

During normal respiration, driving pressure is the direct force that is necessary to expand the whole respiratory system. During inspiration, driving pressure resists the elastic resistance of the respiratory system, and promotes lung tissue and chest wall expansions. Then, the gas enters the lungs to complete the inspiration. From respiratory mechanics, compliance of respiratory system (CRS) indicates the changes in lung volume under unit pressure, that is, CRS = VT/driving pressure. Therefore, driving pressure can be defined as the ratio of tidal volume (VT) to CRS[7], which reflects the changes in lung stress and lung strain[8]. These changes are important factors that cause mechanical ventilation-related lung injury (VILI). During mechanical ventilation, driving pressure can be simplified as platform pressure (Pplat)-PEEP [9]. Under constant flow ventilation with controlled volume, an inspiratory pause ≥ 3 s can provide an optimized platform pressure. Theoretically, the optimized mechanical ventilation method selects the minimum driving pressure as the guide, and sets the optimized PEEP to achieve minimum lung injury.

Posterior lumbar interbody fusion is performed under general anesthesia and mechanical ventilation. In the prone position, the mediastinum and heart compress less on dorsal lung tissues, with uniform pressure distribution in the chest cavity, which makes the alveolar in the gravity-dependent area to quickly expand, thereby increasing lung compliance[10]. The activities in the prone position can also lead to decreased chest wall compliance, which causes changes in respiratory mechanics. Meanwhile, most patients who undergo posterior lumbar interbody fusion are elderly and their alveolar gas exchange as well as pulmonary functions are relatively vulnerable. When the same mechanical ventilation mode is applied to different patients, it produces beneficial effects in some patients, while others may only develop complications such as pulmonary and hemodynamics disorders. Therefore, there is a need to assess the respiratory mechanics of elderly patients who undergo posterior lumbar interbody fusion and to set individualized mechanical ventilation parameters. Therefore, we conducted a single-center pilot study to investigate the effects of driving pressure-oriented mechanical ventilation on perioperative arterial oxygenation in elderly patients undergoing posterior lumbar interbody fusion, and to observe the safety of the intraoperative application of this ventilation mode to lay a reliable foundation for further clinical trial.

METHODS

We conducted a pilot study; this study was approved by the Ethical Committee of the First Affiliated Hospital of Nanchang University (IIT2022011) and was conducted following the Declaration of Helsinki. Prior to their involvement in this study, the patients or their legal guardians were asked to sign a written informed consent. This trial is registered at www.medresman.org (ChiCTR2100054078), and the date of first registration was 08/12/2021 .

Elderly patients who underwent posterior lumbar interbody fusion at the Department of Anesthesiology of the First Affiliated Hospital of Nanchang University were included in this study. The inclusion criteria were: i. Patients aged 55-75 years old; ii. Patients with Grade III ASA; iii. Patients whose expected operation time was ≥ 2 h, and iv. Patients who agreed to sign an informed consent for their inclusion in the clinical trial and receive follow-up and treatment. The exclusion criteria were: i. Patients with acute lung injury or

with heart NYHA Grade Ⅲ-Ⅳ; iii. Patients who developed chronic renal failure and liver failure within three months; iv. Patients with a history of pulmonary bullae, pneumothorax diseases or lobectomy or segmental resection; v. Obese patients (BMI > 42 for male, BMI > 35 for female); vi. Patients with neuromuscular diseases (e.g., myasthenia gravis, periodic paralysis); vii. Patients who opted out of the test, and viii. For patients with intraoperative blood loss >1000 mL, the operation was either canceled, the operation method was changed or the unplanned second operation was performed.

The experiment was simply randomized using random number table. The enrolled patients were randomized at a ratio of 1:1 into the driving pressure-oriented mechanical ventilation group (Group P) and the LPVS group (Group C). The test was partially blind; since the anesthesiologists were required to set the ventilation parameters, they knew about the grouping, while the patients, surgeons and follow-up doctors were blinded to the grouping.

One day before the operation, the patients were subjected to the preoperative interview, and were clear about the time of fasting and drinking and the use of drugs before the operation. On the day of operation, patients were monitored for standardized vital signs in the operating room, and catheterization of the right radial artery and internal jugular vein performed. General anesthesia induction was achieved using 2.0 mg/kg propofol, 0.4 μg/kg sufentanil, and 0.1 mg/kg cisatracurium. Then, BIS was maintained between 44 and 55 under combined intravenous and inhalation anesthesia. The MAQUET FLOW-i anesthesia machine was used for ventilation management, and was adjusted to the volume control mode after endotracheal intubation. The inhaled oxygen concentration (FiO_2) was set to 50%, with 8 mL/kg of V_T (ideal weight, male: 50+0.91×Height-152.4; female: 45.5+0.91×Height-152.4), PEEP 5 cm H_2O, and respiratory rate (RR) 12 times/min as the initial settings. After disconnection of the respiratory circuit, patients were placed in the surgical position and lung recruitment was performed, followed by ventilation management according to grouping.

driving pressure-oriented mechanical ventilation was conducted with FiO_2 50% and V_T 8 mL/kg, while PEEP was set according to the minimum driving pressure. Driving pressure: starting from PEEP=1 cm H_2O, the inspiratory breath-holding button (≥3 s) was pressed and held on the FLOW-i anesthesia machine to record the platform pressure after completing three to four respiratory cycles. The difference between the platform pressure and PEEP at this time was the driving pressure. The PEEP at each stage needed to maintain at least 8 expiratory and inspiratory processes. Then, PEEP increased by 1 cm H2O in turn for measurement of the next stage until PEEP was 10 cm H2O. The driving pressure for each PEEP was recorded. During the whole process, PEEP with the minimum driving pressure was selected as the optimized PEEP, and this PEEP was used to maintain ventilation until the end of operation. Group C: the conventional LPVS was used with FiO2 50%, VT 8 mL/kg and 5 cm H20 PEEP. The setting inspiratory/expiratory ratio (1: E) of the two groups was the same, and the RR was set at 12-16 times/min to ensure that the end-tidal carbon dioxide (PEtCO2) was 35-45 mmHg.

Observation and recording of indicators: Baseline characteristics (age, gender, BMI, AIRSCAT scores, smoking history,etc) and intraoperative variables (operation time, infusion volume (crystal, colloid volume), bleeding volume and urine volume,etc) were recorded. Heart rate (HR), mean arterial pressure (MAP) and arterial blood gas parameters were obtained at the following four-time points: i. Before the patient had inhaled oxygen in the operating room (T0), ii. At 20 min after mechanical ventilation in the prone position (T1); iii. At 20 min before the end of the surgery (T2) and iv. At 20 min after patients had been admitted to the ward (T3).

End points

The primary end point: Perioperative Blood Oxygenation

Radial artery blood of 1 mL were collected from T0 to T3 for arterial blood gas, Then the blood partial pressure of oxygen (PaO2), fraction of inspiration(Fi02) were recorded to calculate

oxygenation index(OI) values. (OI = PaO2/FiO2). Other arterial blood gas parameters including the blood PH value, partial pressure of carbon dioxide (PaCO2), Lactate(Lac),Base excess(BE).

The secondary endpoint:Perioperative Haemodynamic parameters

Hemodynamic parameters mainly included HR, MAP and perioperative adverse cardiovascular events.

The exploratory endpoints:Perioperative ventilation parameters and the incidences of postextubation hypoxemia.

Postextubation hypoxemia, defined as peripheral oxygen saturation (Spo2) of less than 90% within 10 min of extubation or until departure from the operating room[11].

Sample size determination and statistical analyses

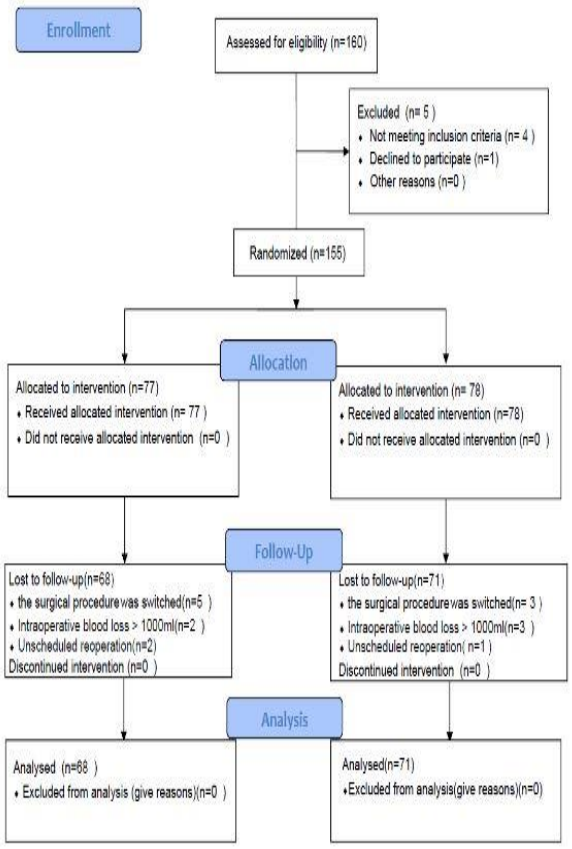
This study was designed as a pilot study. Thus, no a priori sample size calculation could be performed. Because we expected small to medium effect sizes, a sample size of n = 80 per group.

Statistical analyses were performed using the SPSS26.0 statistical software. Measurement data conforming to normal distribution are expressed as mean±SD (X±SD), while count data are expressed as percentages. The t-test or non-parametric tests were used to compare the means. Comparisons of rates between the two groups were performed using the $\chi 2$ test or Fisher's exact probability method. $p \leq 0.05$ was the threshold for statistical significance.

RESULTS

A total of 160 patients were enrolled in this trial, of which 5 patients were excluded because they did not meet the inclusion criteria, and then 155 patients were randomized. In group C, 5 patients changed the surgical method, 2 patients lost more than 1000ml of blood, and 2 patients were excluded because of unplanned second surgery after surgery. In group P, 3 patients changed the surgical method, 3 patients lost more than 1000ml of blood, and 1 patient was excluded from the second unplanned surgery after surgery. Finally, 139 patients were included in the statistical analysis (Figure 1:Flow Diagram).

Figure 1 :



Differences in gender, age, BMI, albumin, hemoglobin, AIRSCAT score, creatinine, smoking history, comorbidities (such as hypertension, diabetes, chronic obstructive pulmonary disease (COPD)), operation time, urine volume, bleeding volume and input colloid and crystal volume between the two groups were insignificant($p>0.05$; Table 1)(on page 14).

Perioperative Haemodynamic parameters

Differences in hemodynamics parameters of the two groups at different moments (T0, T1, T2, T3) were not significant ($p>0.05$; Figure 2,3: Changes in hemodynamic variables(Heart rate; mean blood pressure)). Moreover, no serious adverse cardiovascular events were observed.

Table 1 : Baseline characteristics of participants and other intraoperative variables in two groups: Group P is the experimental group and group C is the control group

Characteristic	C Group(n=68)	P Group(n=71)	t/χ2	P
Sex, Number (Percentage)			2.152	0.142
Male	41	34		
Famale	27	37		
Age（Y）, Mean ± SD	58.02 ± 9.86	59.92 ± 9.34	0.797	0.428
BMI(Kg/m2) , Mean ± SD	21.91 ± 2.72	22.73 ± 3.13	1.564	0.122
Albumin (g/L), Mean ± SD	40.21 ± 3.76	40.89 ± 8.19	0.624	0.534
Hemoglobin (g/L), Mean ± SD	130.01 ± 16.68	129.98 ± 16.60	0.01	0.992
Creatinine（μmmol/L), Mean ± SD	76.15 ± 48.247	67.53 ± 14.517	1.439	0.152
C-reactive protein(mg/L), Mean ± SD	10.17 ± 18.322	7.25 ± 17.406	0.959	0.339
AIRSCAT score, Number (Percentage)			0.233	0.629
Low	26（38.2%）	30（42.3%）		
Moderate	42（61.8%）	41（57.7%）		
High	0	0		
Smoking, Number (Percentage)			0.294	0.588
Yes	17（25%）	15（21.1%）		
No	51（75%）	56（78.9%）		
hypertension, Number (Percentage)			0.166	0.684
Yes	8（11.8%）	10（14.1%）		
No	60（88.2%）	61（85.9%）		
Diabetes, Number (Percentage)			0.004	0.947
Yes	5（7.4%）	4（5.6%）		
No	63（92.6%）	67（94.4%）		
Chronic obstructive pulmonary disease, Number (Percentage)			0.044	0.834
Yes	6（8.8%）	7（9.9%）		
No	62（91.2%）	64（90.1%）		
Operation time(min) , Mean ± SD	202.8±73.2	223.2±79.2	0.982	0.330
Urinary volume（ml）, Mean ± SD	546.17±247.72	514.62±284.93	0.492	0.624
Blood loss(ml) , Mean ± SD	492.27±420.14	435.43±380.32	1.663	0.100
Infusion volume（ml）, Mean ± SD				
liquid	1303.76±331.21	1191.67±288.80	1.430	0.157
colloid	553.89±255.47	505.21±219.1	0.805	0.423

Figure 2 :

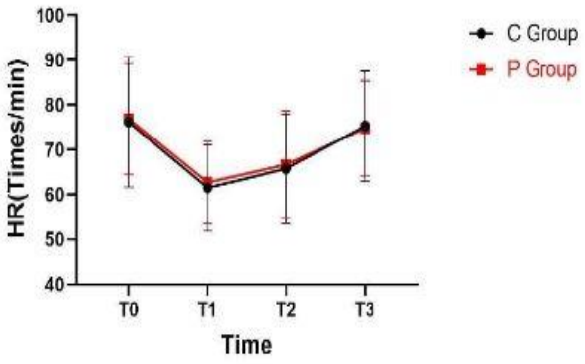


Figure 3 :

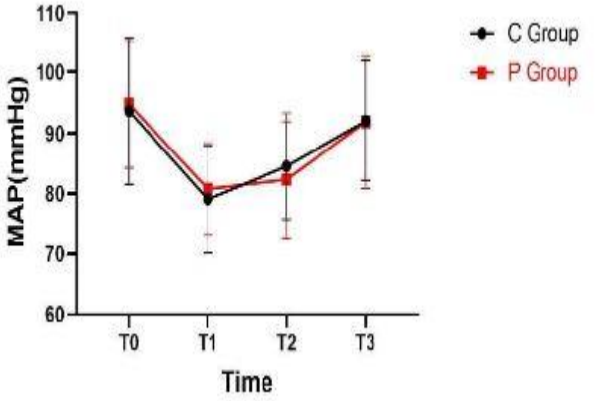


Table 2 : Arterial blood gas measurements Group P is the experimental group and group C is the control group

Arterial blood gas measurements	Time	C Group(n=68)	P Group(n=71)	t	p
PH, Mean±SD	T_0	7.44±0.04	7.43±0.03	0.360	0.720
	T_1	7.40±0.04	7.41±0.03	0.259	0.796
	T_2	7.39±0.04	7.38±0.03	0.118	0.852
	T_3	7.36±0.04	7.36±0.05	0.536	0.594
PaCO2（mmHg）, Mean±SD	T_0	37.89±2.83	39.84±3.21	1.797	0.080
	T_1	38.03±3.82	38.68±2.73	0.790	0.432
	T_2	39.18±4.42	40.17±2.90	0.986	0.329
	T_3	40.22±4.41	40.35±4.43	0.292	0.771
PaO2（mmHg）, Mean±SD	T_0	94.07±12.47	89.67±11.17	0.960	0.338
	T_1	242.17±41.26	252.65±20.69	1.151	0.254
	T_2	236.29±25.44	253.04±21.44	2.456	0.017*
	T_3	88.27±14.03	91.20±27.24	0.514	0.610
Pao2/Fio2, Mean±SD	T_0	447.58±59.70	427.06±53.44	0.96	0.338
	T_1	497.25±84.92	515.75±46.17	0.983	0.329
	T_2	485.73±58.67	517.84±47.76	2.076	0.043*
	T_3	420.58±66.81	434.21±129.40	0.514	0.610
Lactate(mmol/L), Mean±SD	T_0	2.37±0.83	2.07±0.97	0.940	0.349
	T_1	2.32±1.00	2.24±0.73	0.444	0.658
	T_2	2.15±0.89	1.87±0.42	1.567	0.123
	T_3	2.69±1.44	3.03±1.75	0.755	0.453
Base excess, Mean±SD	T_0	1.79±2.60	1.92±1.87	0.348	0.729
	T_1	-0.77±1.99	-0.06±1.81	1.673	0.097
	T_2	-1.20±1.84	-0.90±1.57	0.997	0.320
	T_3	-2.98±2.20	-2.36±2.73	1.487	0.140
*P ＜0.05 indicates statistically significant values.					

Intraoperative ventilation and blood gas parameters

Differences in minimum driving pressures for Groups P and C were significant (7.47±1.17 and 8.79±1.44 cm H2O, respectively, p<0.05); the PEEP for Group P was 7.03±1.08 cm H2O, which was significantly higher than that of Group C (p<0.05; Figure 4: Changes in ventilation parameter). Partial pressure for oxygen and oxygenation index for Group P at T2 were significantly higher than those of Group C (p<0.05), while differences in pH values, PaCO2, lactate, and base excess values were not significant (p>0.05; Table 2)(on page 15). Differences in VAS scores of the two groups at 6 h, 12 h, and 24 h after surgery were not significant (Table 3).

Figure 4 :

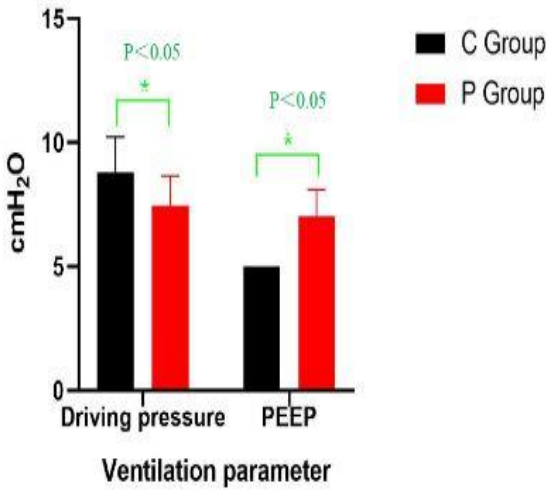


Table 3 : VAS pain scores Median (Inter Quartile Range)

Time	C Group(n=68)	PGroup(n=71)	P
6 Hours postoperatively	4(0)	4(0)	0.588
12 Hours postoperatively	2(0)	2(1)	0.108
24 Hours postoperatively	2(0)	2(0)	0.662

Incidence rates of postextubation hypoxemia in the two groups

Differences in incidence rates of postextubation hypoxemia between Groups C and P (11.7% and 9.9%, respectively, p>0.05; Table 4).

DISCUSSION

For elderly patients subjected to posterior lumbar interbody fusion, there is a decrease in their pulmonary functions. Due to the influence of related factors such as ventilator-associated lung injury and blood transfusion under mechanical ventilation, the incidence rates of PPCs in this group should not be underestimated. Therefore, intraoperative LPVS is one of the essential measures for reducing PPCs [4]. Xx et al [13]. reported that the

Table 4 : The incidence of postextubation hypoxemia(Number (Percentage))

case	C Group (n=68)	PGroup(n=71)	P
postextubation hypoxemia	8 (11.7%)	7 (9.9%)	0.929
*P ＜0.05 indicates statistically significant values.			

prone position can improve the oxygenation and survival rates of patients with acute respiratory distress syndromes (ARDS). Mechanistically, the gravity-dependent and non-gravity dependent areas might have changed at the prone position, thereby improving the atelectasis of ARDS patients. Pressure distribution in the chest cavity was uniform at the prone position, which affected CRS, reduced alveolar expansion heterogeneity, and improved the ventilation/perfusion ratio. However, for elderly patients subjected to posterior lumbar interbody fusion, there are no reference models on how to set appropriate respiratory parameters and implement safe and effective LPVS for this group, particularly based on CRS at the prone position and changes in ventilation/perfusion ratio. Therefore, we conducted a pilot study to investigate the effects of driving pressure-oriented mechanical ventilation on perioperative arterial oxygenation in elderly patients undergoing posterior lumbar interbody fusion, and to observe the safety of the intraoperative application of this ventilation mode to lay a reliable foundation for further clinical trial.

A prone position may affect venous reflux and right ventricular functions [14], and exorbitant PEEP affects circulation. To avoid severe intraoperative hemodynamics fluctuations, the high value of PEEP titration in this study was limited to 10 cm H2O. Additionally, the international expert consensus meeting was not unanimous in its recommendation of 0 cm H2O PEEP [4]. Therefore, we set the PEEP titration at 1-10 cm H2O. Anesthesia induction-assisted ventilation and tracheal tube removal resulted in atelectasis when patients were put in the prone position. A manual recruitment maneuver was performed before PEEP titration. In the pilot study, we found that PEEP levels under minimum driving pressure in Group P were 2 to 3 consecutive values, rather than a single value, which has never been reported before. Moreover, in the pre-test, we compared the intraoperative oxygenation indices of maximum and minimum PEEP under minimum driving pressure. It was found that to maintain the minimum driving pressure, patients with relatively high PEEP had better intraoperative oxygenation indices. Therefore, to ensure the benefit of patients during operation, the largest PEEP among the consecutive PEEP was used in this study. As indicate the driving pressure in Group C was 8.79±1.44 cm H2O, with a PEEP of 5 cm H2O. The minimum driving pressure in Group P was 7.47±1.17 cm H2O, as measured using the MAQUET FLOW-i anesthesia machine, which is not only lower than that of the control group, but is also in line with the recommended driving pressure safety threshold (<15 cm H2O) [15]. Under minimum driving pressure, PEEP was 7.03±1.08 cm H2O, higher than that of Group C. Under these ventilation parameters, the partial oxygen pressure and oxygenation index at T2 in Group P were significantly higher than those in Group C. The oxygenation index is a sensitive indicator for clinical assessment of oxygenation of patients. Bendixen et al.[16] was the first report that after endotracheal intubation and mechanical ventilation, atelectasis was the principal consideration for increased intrapulmonary shunt and hypoxemia. Without monitoring atelectasis, changes in intraoperative oxygenation indices during the operation were associated with formation and number of atelectasis after the operation. In this study, a driving pressure-oriented ventilation strategy not only improved the high driving pressure-induced mechanical injury, but also achieved personalized PEEP, which reduced the collapse of lung tissues, increased the area of gas and blood exchange, and increased the oxygenation index. This strategy also maintained more open alveoli and effective gas exchange during the operation, reduced ventilation-induced blood flow disorders, and improved the intraoperative oxygenation of elderly patients who underwent posterior lumbar interbody fusion.

Applications of anesthetic drugs and management of perioperative fluids have also been closely associated with PPCs. In 2010, Canet et al. [17] developed the ARISCAT scoring scale to predict PPCs of the relevant surgical population. Therefore, we scored the patients before surgery. Differences in ARISCAT scores between the two groups were insignificant, which ruled out the influence of preoperative baseline factors on the occurrence of PPCs. Improper fluid infusions might result in low or overload volume, affecting lung tissue perfusion and overall outcomes. A

previous prospective and multicenter RCT study [18] revealed that guided target-oriented fluid therapy(GDT) based on SV and SVV can reduce the occurrence and mortality rates due to PPCs during transthoracic esophagectomy. Therefore, the SVV-GDT was used in both groups to minimize lung-associated adverse events related to infusion factors. Differences in intraoperative infusion volume between the two groups were not marked, which ruled out the influence of lung-related adverse events that are caused by fluid factors. Additionally, there were marked differences in postoperative VAS scores between the groups, implying a reduced impact of postoperative pain on postoperative atelectasis.

During surgery, driving pressure was closely associated with the occurrence of PPCs. Generally, PPCs are defined as complications that affect the respiratory system. The definition of PPCs obtained from the European perioperative clinical results [19] working group, which defines it as complications of respiratory tract infection, respiratory failure, pleural effusion, atelectasis, pneumothorax, bronchospasm, and inhalation pneumonia. A randomized control trial involving 292 patients undergoing elective thoracic surgery revealed that when the driving pressure guided individualized PEEP ventilation during one-lung ventilation was at the same VT, there was a reduced occurrence of pulmonary complications three days after surgery in the driving pressure guidance group, compared with the conventional LPVS[20]. In a recent meta-analysis [21], the occurrence of PPCs was associated with driving pressure only, and it only declined when the driving pressure was reduced due to changes in ventilator parameters. Therefore, during mechanical ventilation, driving pressure can be the primary clinical goal for improving the prognosis of patients and reducing the occurrence of PPCs. However, in this pilot study, PPCs were not directly taken as one of the endpoints due to the time and cost of examination. Instead, the incidence rates of postextubation hypoxemia in the two groups was compared to explore the clinical significance of driving-pressure-oriented ventilation. In this study, the occurrence rate of postextubation hypoxemia in Group P was 9.9%, which was lower than that in Group C (11.7%), but there was no statistical significance. This suggests that although driving pressure-oriented mechanical ventilation improves intraoperative oxygenation, it does not improve the postoperative hypoxemia in elderly patients with posterior lumbar interbody fusion, and the advantages of this mechanical ventilation parameter setting need to be further explored.

Appropriate PEEP does not affect hemodynamic stability. To verify the effects of driving pressure-oriented mechanical ventilation on hemodynamics, we assessed the hemodynamic changes of patients during the perioperative period. In this study, differences in MAP and heart rates between the groups were not significant, and no malignant adverse events were observed during measurement of minimum driving pressure. Therefore, driving pressure-oriented mechanical ventilation is a safe and reliable clinical tool as it does not result in severe hemodynamics fluctuations.

This study has some limitations. First, this was a pilot feasibility study. Thus, the results of our study cannot readily be generalized to other settings yet. Second, according to driving pressure = Pplat - PEEP, when the minimum driving pressure is measured by incremental PEEP, the high PEEP is selected based on unchanged minimum driving pressure. Due to the test conditions, we could not use the electrical impedance technology, intraoperative lung CT and other imaging methods to assess the intraoperative lung volume during surgery. The use of oxygenation index only to select high PEEP does not provide accurate results. Third, the mechanical ventilation in this study was performed with this parameter after the minimum driving pressure was measured once, and lung compliance may change after long-term mechanical ventilation. Therefore, our follow-up study is focused on dynamic monitoring of driving pressure to set the mechanical ventilation parameters. Finally, this pilot study only discussed the effects of driven pressure-oriented mechanical ventilation on intraoperative oxygenation and post-extubation hypoxemia, to further explore its effects on PPCs, in addition to expanding the sample size, more time and money should be invested.

CONCLUSIONS

The driving pressure-oriented mechanical

ventilation enhances the intraoperative oxygenation of elderly patients who underwent posterior lumbar interbody fusion, but the incidence of postextubation hypoxemia was not affected.

List of abbreviations

Abbreviations – Instructions
PPCs - Postoperative pulmonary complications
LPVS -Lung protective ventilation strategy
VT -Tidal volume
PEEP -Positive end expiratory pressure
RM -Recruitment maneuvers
CRS -Compliance of respiratory system
VILI - Ventilation-related lung injury
Pplat -Platform pressure
RR- Respiratory rate
HR -Heart rate
MAP -Mean arterial pressure
PaO2 - Partial pressure of oxygen
Fi02 -Fraction of inspiration
OI -Oxygenation index
PaCO2 -Partial pressure of carbon dioxide
Lac -Lactate
BE -Base excess
Spo2 -Peripheral oxygen saturation
COPD -Chronic obstructive pulmonary disease
ARDS - acute respiratory distress syndromes
GDT -Guided target-oriented fluid therapy

DECLARATIONS

Ethics approval and consent to participate

This pilot study was approved by the Ethics Committee of the First Affiliated Hospital of Nanchang University with the ethics approval number IIT2022011. All patients participating in the study or their legal guardians have been asked to sign a written informed consent form.

Consent for publication

All authors reviewed the article and consented to publish it.

Availability of data and materials

All datas and materials are available and veritable .The datasets are not publicly available due to some other data is still being analyzed ,but are available from the corresponding author on reasonable request.

CONFLICTS OF INTEREST

Competing interests

All authors report no financial interests or potential conflicts of interest.

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Authors' contributions

LCQ and ROY designed and wrote the program of the trial, HYG and DDL completed the trial and data collection, ML completed the production of related charts, and YJ conducted the follow-up of adverse events.

The transparency statement

We affirm that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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