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Original Article

Impact of nasal high-flow humidified oxygen therapy on oxygenation index and respiratory function in patients with Stanford Type B aortic dissection and hypoxemia

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Abstract: Objective: To evaluate the efficacy of nasal high-flow humidified oxygen therapy (HFHO) in improving oxygenation and respiratory function. Methods: This retrospective analysis included 193 patients with Stanford Type B aortic dissection and hypoxemia admitted to Xingtai People's Hospital from January 2020 to January 2023. Patients were divided into two groups: HFHO (n = 107) and conventional oxygen therapy (CO, n = 125). The primary endpoints included changes in the oxygenation index (PaO_2/FiO_2), respiratory parameters, and Radiological Atelectasis Score (RAS). Secondary outcomes included re-intubation rates, ICU length of stay, and overall hospital stay duration. Results: Baseline demographic and disease characteristics were similar between groups (all $P > 0.05$). The HFHO group displayed a significant improvement in PaO_2/FiO_2 post-treatment (225.55 ± 3.28 mmHg) compared to the CO group (224.56 ± 2.31 mmHg; $P = 0.010$). The HFHO group also had a significantly lower respiratory rate (24.71 ± 0.89 bpm; $P = 0.038$) and higher SpO_2 (90.92% ± 0.93%; $P < 0.001$) post-treatment. Additionally, HFHO was associated with a lower re-intubation rate (6.54% vs 17.6%; $P = 0.011$) and shorter ICU (3.88 ± 0.63 days; $P = 0.023$) and hospital stays (10.57 ± 0.6 days; $P = 0.004$). The RAS significantly improved in the HFHO group by days 3-5 post-operation (1.17 ± 0.3; $P = 0.008$). Conclusion: HFHO offers superior outcomes in oxygenation and respiratory function compared to conventional oxygen therapy in patients with Stanford Type B aortic dissection and hypoxemia.

Keywords: Stanford Type B aortic dissection, hypoxemia, nasal high-flow humidified oxygen therapy, oxygenation index, postoperative care, respiratory function

Introduction

Stanford Type B aortic dissection is a critical cardiovascular condition characterized by the separation of the aortic wall layers, originating from a tear in the intima of the descending aorta [1]. This condition often presents with high morbidity and mortality rates, which are exacerbated by complications such as hypoxemia - a state of abnormally low blood oxygen levels [2, 3]. Hypoxemia is frequently observed postoperatively in patients with aortic dissection and it contributes significantly to respiratory dysfunction, complicating recovery and increasing the risk of adverse outcomes [4]. Therefore, effective management of hypoxemia is vital to improving clinical outcomes and enhancing the recovery process.

Traditional management of postoperative hypoxemia in Stanford Type B aortic dissection patients typically relies on conventional oxygen therapies [5, 6]. These include low-flow nasal cannulas and Venturi masks, which deliver fixed concentrations of oxygen to alleviate hypoxemia. However, these methods often fail to achieve optimal oxygenation, particularly in patients with compromised respiratory function [7]. The limitations of conventional oxygen therapy highlight the need for innovative interventions that improve oxygen delivery and respiratory mechanics [8].

High-flow nasal cannula (HFNC) systems, which deliver nasal high-flow humidified oxygen therapy (HFHO), have recently emerged as a promising alternative for managing respiratory insufficiency [9]. HFHO delivers a high flow rate of humidified and heated gas, offering several physiological benefits [10]. The high flow rates help reduce anatomical dead space, provide continuous positive airway pressure, and im-

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prove alveolar recruitment [11]. These advantages are particularly beneficial in conditions such as aortic dissection recovery, where respiratory workload and atelectasis are common [12].

The efficacy of HFHO has been demonstrated in various clinical contexts. In patients with acute hypoxemic respiratory failure, HFHO has been shown to reduce the need for intubation and improve oxygenation compared to standard oxygen therapy [13]. Postoperatively, HFHO has reduced the incidence of atelectasis, improved oxygenation, and led to shorter ICU stays and reduced hospitalization durations [14]. In patients with chronic obstructive pulmonary disease (COPD) exacerbations, HFHO has been associated with lower rates of treatment failure and re-intubation, suggesting its role in both acute and chronic respiratory management [15].

Despite these theoretical benefits, the use of HFHO in Stanford Type B aortic dissection patients has not been extensively studied, leaving a gap in the literature regarding its efficacy in this cohort [16]. The unique physiological challenges of Stanford Type B aortic dissection, coupled with the postoperative environment, provide a compelling rationale for investigating the potential benefits of HFHO [17]. This study aims to explore the impact of HFHO on oxygenation indices and respiratory function, extending insights from its successful use in other respiratory and non-respiratory conditions.

Materials and methods

Study design

A retrospective analysis was performed on 193 patients diagnosed with Stanford Type B aortic dissection and hypoxemia, admitted to Xingtai People's Hospital between January 2020 and January 2023. The patients were categorized based on the type of oxygen therapy they received. The group that received nasal HFHO included 107 patients and was designated the HFHO group, while the conventional oxygen therapy (CO) group consisted of 125 patients. Data were extracted from the hospital's medical records, including demographic information, baseline disease characteristics, routine blood test results, heart rate (HR), blood pressure, oxygenation index parameters, respiratory function parameters, radiological atelectasis scores (RAS), as well as lactic acid, hemoglobin, and blood glucose levels within 6 hours after surgery. The primary outcomes were oxygenation index parameters and respiratory function parameters.

Inclusion and exclusion criteria

Inclusion criteria: Patients were included if they met the diagnostic criteria for Stanford Type B aortic dissection [18] and satisfied the hypoxemia criteria, defined by a pre-extubation oxygenation index (PaO_2/FiO_2) of ≤ 300 mmHg (1 mmHg = 0.133 kPa) [19]. Additionally, patients were required to have complete medical records and to have received oxygen therapy.

Exclusion criteria: Patients were excluded if they experienced visceral or limb ischemia within two weeks of admission, had a history of asthma, suffered from infectious diseases or autoimmune disorders, died within 24 hours of treatment, showed reduced swallowing and cough reflexes with altered consciousness post-treatment, or developed severe complications after treatment, such as coma, cardiogenic shock, gastrointestinal ischemia, cardiac arrest, or multi-organ dysfunction.

Ethics statement

The Institutional Review Board and Ethics Committee of Xingtai People's Hospital approved this study. Informed consent was waived due to the retrospective nature of the study and the use of de-identified patient data, which posed no risk to patient care. This waiver was granted in compliance with regulatory and ethical standards for retrospective research.

Treatment approach

All surgeries for Stanford Type B aortic dissection were performed under general anesthesia with the use of cardiopulmonary bypass. Following surgery, patients were transferred to the Cardiac Surgery Intensive Care Unit (CSICU). Once extubated, patients routinely received oxygen via nasal cannula at a flow rate of 1-3 L/min. Patients in the CO group who developed postoperative hypoxemia were provided with oxygen through a Venturi mask at a flow rate of 6-8 L/min. In contrast, patients in the HFHO group received treatment using a

Fisher & Paykel system, which included an air-oxygen blender, MR850 humidifier, specialized breathing circuit, and nasal cannula. This HFNC system delivered gas at a flow rate of 35-60 L/min, heated to 37°C, with an oxygen concentration of 60%-80%. If a patient's condition deteriorated and met the criteria for intubation, non-invasive oxygen therapy was discontinued, and invasive mechanical ventilation was initiated. Both treatment protocols were administered for 48 hours.

During oxygen therapy, nasal cannulas were secured to patients using head straps, with parameters adjusted based on each patient's respiratory condition. For both groups, the following parameters were monitored and recorded prior to and after treatment: HR, respiratory rate (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP), oxygenation index (PaO_2/FiO_2), oxygen saturation (SpO_2), and $PaCO_2$ levels. Patients' lactate, hemoglobin (Hb), and blood glucose levels were monitored within 6 hours postoperatively. Additionally, the requirement for non-invasive mechanical ventilation and subsequent tracheal intubation due to treatment failure was documented. Radiologists performed chest X-rays on patients from Day 1 to Day 5 post-extubation and evaluated atelectasis severity using the RAS, which ranged from 0 to 10 [20].

Criteria for reintubation

The criteria for reintubation included the following: respiratory or cardiac arrest; apnea with loss of consciousness or gasping; psychomotor agitation inadequately controlled by sedation; massive aspiration; persistent inability to clear respiratory secretions; HR falling below 50 beats per minute with associated loss of alertness; and severe hemodynamic instability unresponsive to fluid resuscitation and vasoactive medications [21].

Routine blood tests

Fasting venous blood samples (5 mL) were collected from patients in the early morning after treatment. These samples were centrifuged at 3,000 rpm for 10 minutes using a low-temperature, high-speed centrifuge (TLD 12A, Hunan Xiangxi Scientific Instrument Factory, China). The resulting plasma was stored at -80°C. Red blood cell (RBC) count, white blood cell (WBC) count, platelet count, and Hb levels were analyzed using a hematology analyzer (SYSMEX SE-9000, SYSMEX Corporation, Japan).

Statistical analysis

The minimum sample size was calculated using G * Power to detect a significant difference with a significance level (α) of 0.05 and a power (1 - β) of 0.95. The required sample size was determined to be 88 patients. The sample size was calculated using the following formula:

$$n = [(Z1-\alpha/2 + Z1-\beta)/d]^2 \times [p1 (1-p1) + p2 (1-p2)]$$

Where: $Z1-\alpha/2$ is the standard normal deviate corresponding to the desired significance level (1.96 for $\alpha = 0.05$). $Z1-\beta$ is the standard normal deviate corresponding to the desired power (1.645 for power = 0.95). d is the effect size (difference in proportions between the two groups). p1 and p2 are the expected proportions in the two groups.

Data analysis was conducted using SPSS 29.0 statistical software (SPSS Inc., Chicago, IL, USA). Categorical data were expressed as [n (%)]. The chi-square test was used when the sample size was ≥ 40 and the theoretical frequency (T) was ≥ 5, with the test statistic denoted by χ^2. If the sample size was ≥ 40 but the theoretical frequency was between 1 and < 5, an adjusted chi-square test was performed using a correction formula. For sample sizes < 40 or when T < 1, Fisher's exact test was applied.

Continuous variables were assessed for normality using the Shapiro-Wilk test. Normally distributed continuous data were expressed as (X ± s). For non-normally distributed data, the Wilcoxon rank-sum test was used, with results reported as [median (25th percentile, 75th percentile)]. A *p*-value of less than 0.05 was considered statistically significant. Correlation analysis was conducted using Pearson's correlation for continuous variables and Spearman's correlation for categorical variables.

Results

Comparison of demographic characteristics

The demographic characteristics of the cohort study comparing patients undergoing conventional oxygen therapy (CO group, n = 125) with

those receiving nasal HFHO group (n = 107) are outlined in **Table 1**. No statistically significant differences were observed between the two groups across multiple indices. The mean age in the CO group was 60.72 ± 9.72 years, compared to 59.31 ± 8.18 years in the HFHO group (P = 0.240). Gender distribution was similar, with 69.6% males in the CO group and 66.36% in the HFHO group (P = 0.597). Ethnic composition was primarily Han Chinese, representing 81.6% in the CO group and 79.44% in the HFHO group (P = 0.678). Mean body mass indices were comparable: 22.64 ± 2.55 kg/m^2 in the CO group and 22.24 ± 2.84 kg/m^2 in the HFHO group (P = 0.261). Other variables such as smoking history, drinking history, educational level, and marital status showed no significant differences (P > 0.05). Baseline health conditions, including hypertension, diabetes, and dyslipidemia, as well as prior medical conditions like myocardial infarction, coronary artery disease, and cardiac arrhythmia, were also comparable between the two groups (P > 0.05). Additionally, family histories of aneurysm or dissection were similar (P = 0.623). Overall, baseline demographic and health characteristics were statistically equivalent, ensuring comparability in subsequent analyses of therapeutic outcomes.

The maximum diameter of the dissected aorta was similar between groups, with an average of 43.59 ± 9.32 mm in the CO group and 44.26 ± 9.64 mm in the HFHO group (P = 0.591) (**Table 2**). The distribution of false lumen perfusion (fully perfused vs partially thrombosed) was comparable, with 34.4% and 36.45% showing partial thrombosis in the CO and HFHO groups, respectively (P = 0.745). Lesion location, whether confined to the descending thoracic aorta or involving the abdominal aorta, showed no significant variation between groups (P = 0.354). Regarding the type of aortic dissection, the proportions of non-communicating and communicating types were similar, with the CO group presenting 40.8% non-communicating and 58.4% communicating types, compared to 32.71% and 67.29% in the HFHO group (P = 0.203 and P = 0.163, respectively). The incidence of partially thrombosed dissections approached statistical significance, with 23.2% in the CO group and 33.64% in the HFHO group (P = 0.077), while the rates of non-thrombosed dissections were nearly identical between the groups (P = 0.804). Overall, disease characteristics at baseline were comparable between the two groups, ensuring a reliable comparison of treatment effects.

The rate of reintubation was significantly lower in the HFHO group (6.54%) compared to the CO group (17.6%) (P = 0.011) (**Table 2**). Additionally, patients in the HFHO group had a shorter ICU stay, averaging 3.88 ± 0.63 days, compared to 4.08 ± 0.64 days in the CO group (P = 0.023). The postoperative hospital stay was also significantly shorter for the HFHO group, with a mean of 10.57 ± 0.60 days versus 10.78 ± 0.53 days in the CO group (P = 0.004). These findings suggest that nasal HFHO may improve hospitalization outcomes, including reduced reintubation rates and shorter stays in both the ICU and hospital for patients with Stanford Type B aortic dissection and hypoxemia.

Comparison of routine blood tests

The RBC count was slightly higher in the HFHO group (5.36 ± 1.57 × 10^{12}/L) compared to the CO group (5.03 ± 1.14 × 10^{12}/L), though this difference did not reach statistical significance (P = 0.075) (**Table 3**). Hb levels were 131.54 ± 15.57 g/L in the CO group and 128.86 ± 15.38 g/L in the HFHO group, with no significant difference (P = 0.190). Similarly, WBC counts and platelet counts were comparable between the groups, with WBC counts of 9.24 ± 2.57 × 10^9/L in the CO group and 8.97 ± 2.89 × 10^9/L in the HFHO group (P = 0.461), and platelet counts of 19.96 ± 1.46 × 10^4/μL in the CO group and 20.37 ± 2.52 × 10^4/μL in the HFHO group (P = 0.140). Overall, these findings indicate that baseline hematological parameters were similar, allowing for a balanced comparison of therapeutic effects on oxygenation and respiratory function.

Comparison of vital signs

HR was similar between groups, with the CO group exhibiting an average HR of 78.78 ± 18.54 bpm, compared to 80.64 ± 20.42 bpm in the HFHO group (P = 0.469) (**Table 4**). SBP readings were also comparable, with 128.56 ± 13.76 mmHg in the CO group and 125.67 ± 14.74 mmHg in the HFHO group (*P* = 0.124). Similarly, DBP Values showed no significant difference, averaging 76.43 ± 6.37 mmHg in the

Table 1. Comparison of demographic characteristics between the two groups

Index	CO group (n = 125)	HFHO group (n = 107)	t/χ^2	P
Age (years)	60.72 ± 9.72	59.31 ± 8.18	1.178	0.240
Gender (Male/Female)	87 (69.6%)/38 (30.4%)	71 (66.36%)/36 (33.64%)	0.279	0.597
Ethnicity (Han/Other)	102 (81.6%)/23 (18.4%)	85 (79.44%)/22 (20.56%)	0.172	0.678
BMI (kg/m^2)	22.64 ± 2.55	22.24 ± 2.84	1.127	0.261
Smoking history (Yes/No)	83 (66.4%)	69 (64.49%)	0.093	0.760
Drinking history (Yes/No)	30 (24%)	29 (27.1%)	0.293	0.589
Educational level (high school or below/college or above)	23 (18.4%)/102 (81.6%)	18 (16.82%)/89 (83.18%)	0.099	0.753
Marital Status (Married/Unmarried)	60 (48%)/65 (52%)	55 (51.4%)/52 (48.6%)	0.267	0.605
Hypertension (Yes/No)	76 (60.8%)	67 (62.62%)	0.080	0.777
Diabetes (Yes/No)	13 (10.4%)	9 (8.41%)	0.266	0.606
Dyslipidemia (Yes/No)	8 (6.4%)	8 (7.48%)	0.104	0.747
Previous MI (Yes/No)	6 (4.8%)	4 (3.74%)	0.005	0.942
Previous diagnosis of coronary artery disease (Yes/No)	10 (8%)	9 (8.41%)	0.013	0.909
Previous diagnosis of cardiac arrhythmia (Yes/No)	7 (5.6%)	7 (6.54%)	0.090	0.764
Peripheral vascular disease (Yes/No)	6 (4.8%)	4 (3.74%)	0.005	0.942
Family history of aneurysm or dissection (Yes/No)	9 (7.2%)	6 (5.61%)	0.242	0.623

BMI: Body Mass Index; MI: myocardial infarction.

Table 2. Comparison of baseline disease characteristics and hospitalization status between the two groups

Index	CO group (n = 125)	HFHO group (n = 107)	t/χ^2	P
Maximum diameter of dissection aorta (mm)	43.59 ± 9.32	44.26 ± 9.64	0.538	0.591
False lumen (Perfused/Perfused with partial Thrombosis)	82 (65.6%)/43 (34.4%)	68 (63.55%)/39 (36.45%)	0.106	0.745
Lesion location (Descending thoracic aorta only/Abdominal aorta involved)	52 (41.6%)/73 (58.4%)	51 (47.66%)/56 (52.34%)	0.859	0.354
Type of aortic dissection				
- Non-communicating type	51 (40.8%)	35 (32.71%)	1.617	0.203
- Communicating type	73 (58.4%)	72 (67.29%)	1.944	0.163
- Partially thrombosed	29 (23.2%)	36 (33.64%)	3.119	0.077
- Not thrombosed	44 (35.2%)	36 (33.64%)	0.062	0.804
Hospitalization status				
The rate of re-intubation	22 (17.6%)	7 (6.54%)	6.445	0.011
ICU length of stay (d)	4.08 ± 0.64	3.88 ± 0.63	2.288	0.023
Postoperative hospital stay (d)	10.57 ± 0.6	10.78 ± 0.53	2.903	0.004

Table 3. Comparison of routine blood test between the two groups

Index	CO group (n = 125)	HFHO group (n = 107)	T	P
RBC (× 10^{12}/L)	5.03 ± 1.14	5.36 ± 1.57	1.791	0.075
HB (g/L)	131.54 ± 15.57	128.86 ± 15.38	1.316	0.190
WBC (× 10^{9}/L)	9.24 ± 2.57	8.97 ± 2.89	0.739	0.461
Plt (× 10^{4}/μl)	19.96 ± 1.46	20.37 ± 2.52	1.482	0.140

RBC: red blood cell; Hb: hemoglobin; WBC: white blood cell; Plt: platelet.

Table 4. Comparison of heartbeat and blood pressure between the two groups

Index	CO group (n = 125)	HFHO group (n = 107)	T	P
HR (bmp)	78.78 ± 18.54	80.64 ± 20.42	0.725	0.469
SBP (mmHg)	128.56 ± 13.76	125.67 ± 14.74	1.543	0.124
DBP (mmHg)	76.43 ± 6.37	75.82 ± 3.17	0.932	0.352

HR: heart rate; SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

CO group and 75.82 ± 3.17 mmHg in the HFHO group (P = 0.352).

Before treatment (T1), the PaO_2/FiO_2 ratio was similar between groups, with the CO group at 199.77 ± 5.36 mmHg and the HFHO group at 199.63 ± 5.46 mmHg (P = 0.837) (**Figure 1**). After treatment (T2), however, the HFHO group demonstrated a significantly higher PaO_2/FiO_2 ratio, averaging 225.55 ± 3.28 mmHg compared to 224.56 ± 2.31 mmHg in the CO group (P = 0.010). These findings suggest that nasal HFHO may be more effective than conventional oxygen therapy in improving oxygenation in patients with Stanford Type B aortic dissection and hypoxemia.

Initially, at T1, RR, saturation of peripheral oxygen (SpO_2), and partial pressure of carbon dioxide ($PaCO_2$) were comparable between the groups. RR was 36.02 ± 1.53 bpm in the CO group and 35.89 ± 1.55 bpm in the HFHO group (P = 0.528); SpO_2 was 76.49% ± 0.95% in the CO group and 76.39% ± 0.94% in the HFHO group (P = 0.431); $PaCO_2$ was 35.99 ± 1.17 mmHg in the CO group and 35.85 ± 0.92 mmHg in the HFHO group (P = 0.309) (**Figure 2**). After treatment (T2), the HFHO group demonstrated significantly lower RR (24.71 ± 0.89 bpm) compared to the CO group (25.07 ± 1.68 bpm, P = 0.038), and significantly higher SpO_2 (90.92% ± 0.93% vs 89.99% ± 1.13%; P < 0.001). Additionally, $PaCO_2$ levels were significantly reduced in the HFHO group (34.86 ± 1.51 mmHg) compared to the CO group (35.42 ± 1.46 mmHg; P = 0.005). These results suggest that nasal HFHO offers superior improvements in respiratory function parameters for patients with Stanford Type B aortic dissection and hypoxemia.

In the early postoperative period (1-2 days), the RAS was similar between groups, with scores of 1.03 ± 0.28 for the CO group and 1.09 ± 0.31 for the HFHO group (P = 0.097) (**Table 5**). However, by 3-5 days post-operation, the HFHO group exhibited a significantly lower RAS (1.17 ± 0.30) compared to the CO group (1.29 ± 0.36, P = 0.008). These findings suggest that nasal HFHO was associated with less radiological atelectasis over time in patients with Stanford Type B aortic dissection and hypoxemia.

Regarding lactic acid, Hb, and blood glucose levels within 6 hours post-surgery, no significant differences were found between the CO and HFHO groups (**Table 6**). Lactic acid levels were similar between the groups (CO: 3.81 ± 1.42 mmol/L, HFHO: 3.64 ± 1.75 mmol/L; P = 0.417), as were Hb concentrations (CO: 107.45 ± 19.66 g/L, HFHO: 105.35 ± 16.74 g/L; P = 0.385), and blood glucose levels (CO: 8.13 ± 2.04 mmol/L, HFHO: 7.84 ± 2.33 mmol/L; P = 0.305). These findings indicate that the surgical intervention had comparable effects on metabolic and hematological parameters in both groups.

Discussion

Initially, the results demonstrate that HFHO was superior to CO in enhancing the oxygenation index, as indicated by the increased PaO_2/FiO_2 ratio post-treatment. This improvement could be attributed to several factors inherent to the mechanisms of HFHO. The delivery of humidified and warmed high-flow oxygen allows for better mucociliary clearance, which minimizes airway resistance and enhances alveolar ventilation [22]. Furthermore, the high flow rates associated with HFHO generate a continuous positive airway pressure effect,

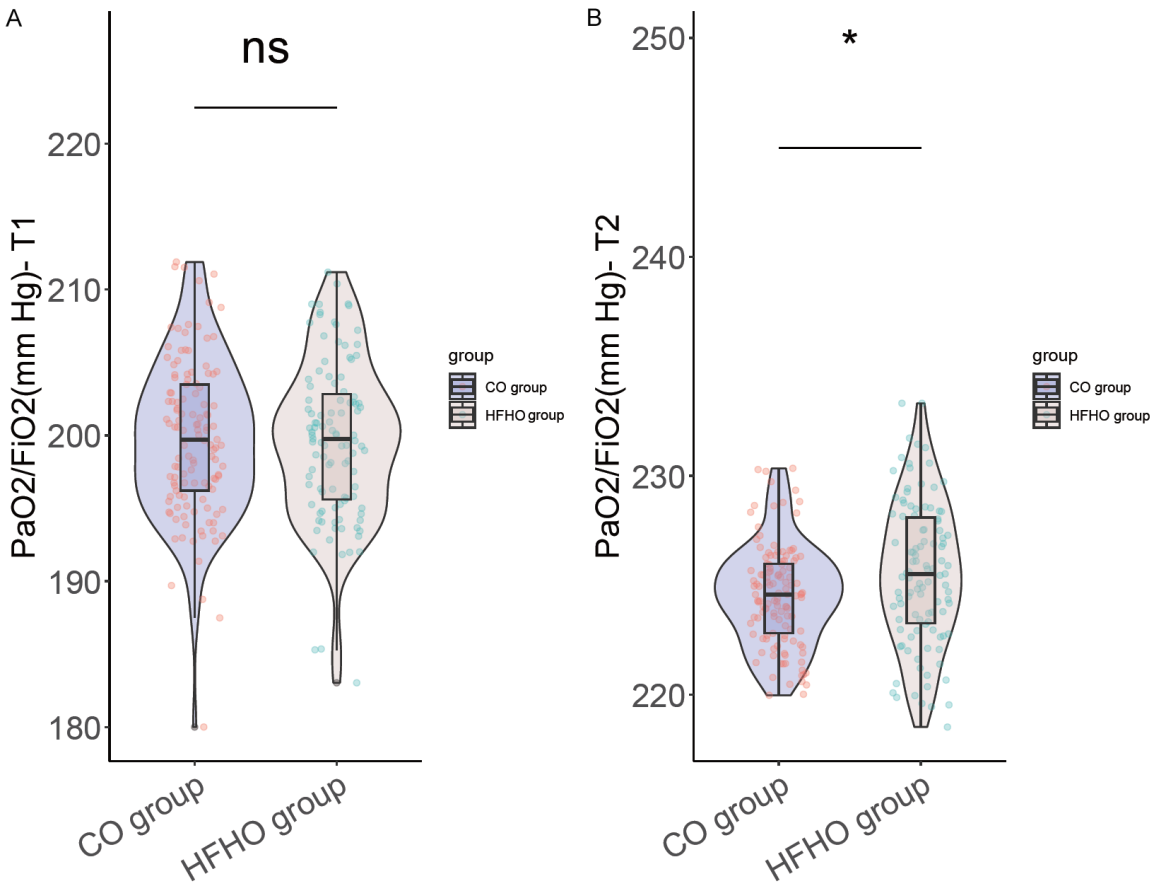

Figure 1. Comparison of changes in oxygenation index parameters at different observation times between the two groups. A. PaO_2/FiO_2 (mmHg)-T1; B. PaO_2/FiO_2 (mmHg)-T2. Note: PaO_2/FiO_2: oxygenation index; T1: before treatment; T2: after treatment; ns, non-significance; *, $P < 0.05$.

reducing inspiratory resistance and facilitating the recruitment of collapsed alveoli [23, 24]. This could explain the observed improvements in SpO_2 and oxygenation index, reflecting better overall oxygen delivery and utilization by the body.

The decreased RR and increased SpO_2 in the HFHO group further underscore the effectiveness of this therapy in alleviating the symptoms of respiratory distress. Reduced work of breathing was a likely mechanism underlying these observations. By providing a high flow of conditioned air, HFHO decreases the anatomical dead space in the respiratory tract, thereby enhancing $PaCO_2$ washout [25, 26]. This improvement in ventilatory efficiency relieves a substantial portion of the respiratory load, allowing patients to sustain a lower RR while maintaining adequate oxygenation and reducing $PaCO_2$ levels [27].

Radiological findings also support the efficacy of HFHO. The reduction in RAS in the HFHO group suggests that this therapy may help prevent or resolve atelectasis, a common complication in postoperative pulmonary care [28]. The ability of HFHO to maintain end-expiratory lung volume and prevent alveolar collapse was crucial in this context, contributing to a better-maintained lung architecture and function [29, 30]. The proactive adoption of HFHO could, therefore, shift the usual postoperative care paradigm by reducing the incidence of respiratory complications, which historically lead to extended hospital stays and higher morbidity rates.

The study also highlights key clinical outcomes that underscore HFHO's broader implications in the postoperative management of patients with aortic dissection. Notably, the HFHO group experienced significantly lower re-intubation

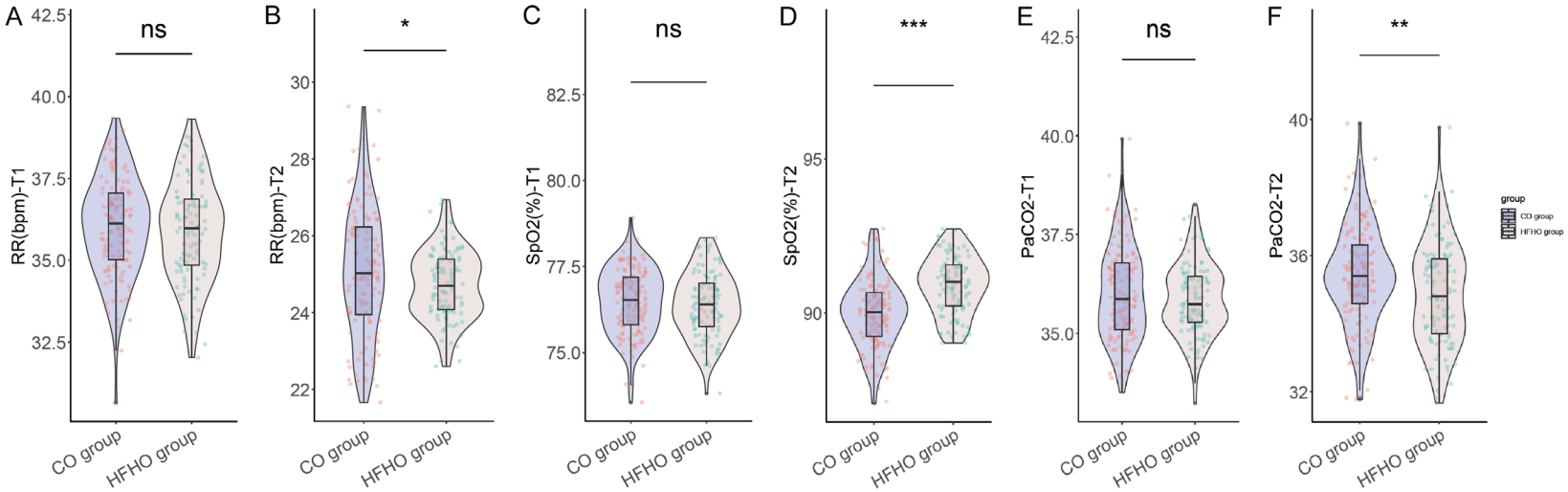

Figure 2. Comparison of changes in respiratory function parameters at different observation times between the two groups. A. RR (bpm)-T1; B. RR (bpm)-T2; C. SpO_2 (%)-T1; D. SpO_2 (%)-T2; E. $PaCO_2$-T1; F. $PaCO_2$-T2. Note: RR: respiratory rate; SpO_2: saturation of peripheral oxygen; ns, non-significance; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

Table 5. Comparison of RAS score between the two groups

Index	CO group (n = 125)	HFHO group (n = 107)	T	P
RAS 1-2 days post-operation	1.03 ± 0.28	1.09 ± 0.31	1.667	0.097
RAS 3-5 days post-operation	1.29 ± 0.36	1.17 ± 0.3	2.671	0.008

RAS: radiological atelectasis score.

Table 6. Comparison of lactic acid, hemoglobin and blood glucose within 6 hours after surgery between the two groups

Index	CO group (n = 125)	HFHO group (n = 107)	t	P
Lactic acid (mmol/L)	3.81 ± 1.42	3.64 ± 1.75	0.814	0.417
HB (g/L)	107.45 ± 19.66	105.35 ± 16.74	0.871	0.385
Blood glucose (mmol/L)	8.13 ± 2.04	7.84 ± 2.33	1.029	0.305

rates and shorter ICU and overall hospital stays. The reduction in re-intubation rates can be attributed to improved oxygenation and respiratory stabilization [31], which decreases the need for invasive mechanical ventilation - a critical milestone that reduces the risk of ventilator-associated lung injuries, infections, and prolonged sedation. Moreover, the shorter ICU and hospital stays for the HFHO group suggest better recovery trajectories, leading to reduced healthcare resource utilization. These outcomes are particularly valuable in resource-limited settings, where they can reduce patient care costs and increase bed turnover rates, thereby improving healthcare efficiency.

The mechanisms through which HFHO exerts its benefits may extend beyond improvements in oxygenation and ventilation. Inflamed and damaged respiratory epithelium, commonly seen in hypoxemic postoperative patients, may recover more rapidly with HFHO use [32]. This effect could result not only from enhanced oxygen delivery but also from the maintenance of mucosal humidification, which prevents desiccation and damage to the tracheobronchial tree [33]. Moreover, the potential for aerosol delivery via HFHO further suggests its therapeutic applications could extend beyond oxygenation, potentially facilitating the administration of anti-inflammatory or bronchodilatory agents.

While this study provides valuable insights into the efficacy of nasal HFHO in improving respiratory outcomes for patients with Stanford Type B aortic dissection and hypoxemia, several limitations must be acknowledged. The retrospective design inherently carries the risk of selection bias and limits the ability to establish causal relationships due to the non-randomized assignment of treatments. Additionally, reliance on de-identified data and medical records may introduce inconsistencies or gaps in data accuracy and completeness. Since the data were collected from existing medical records, the retrospective nature of this study also limits the analysis of other potential confounders. For example, factors such as patient compliance with HFHO treatment and adverse reactions during therapy may influence the outcomes. Non-compliance could result in suboptimal oxygen delivery, leading to hypoxemia, increased respiratory distress, prolonged recovery times, and a higher risk of complications such as atelectasis and respiratory infections. The study's specific patient population may also limit the generalizability of the findings to other groups with differing baseline characteristics or comorbidities. Finally, the study did not assess long-term outcomes after hospital discharge, which would be valuable for understanding the sustained impacts of HFHO therapy.

Future research should address several key areas to expand upon the findings of this study. First, larger and more diverse patient populations are needed to explore the efficacy of HFHO across different subgroups. This would help identify patient characteristics that influence HFHO response, such as age, comorbidities, and baseline respiratory function. Subgroup analyses could enable more tailored treatment strategies, improving outcomes and reducing variability in responses. Additionally, prospective randomized controlled trials are crucial to validate these findings, control for

potential confounders, and provide stronger evidence. Future studies should also investigate the impact of patient compliance on HFHO effectiveness. Adherence to therapy is critical, as factors such as discomfort, nasal dryness, or difficulty maintaining high flow rates may affect compliance. To assess and improve adherence, future studies could employ wearable devices or monitoring technologies to track actual HFHO use. These trials should include long-term follow-up to evaluate sustained benefits and potential long-term effects of HFHO. Long-term follow-up could involve periodic measurements of key parameters such as PaO_2/FiO_2 ratio, SpO_2, and RR over extended periods (e.g., 6 months to 1 year). It should also monitor for long-term complications, rehospitalization rates, and assess mortality and morbidity. A cost-effectiveness analysis should also be conducted to evaluate the economic impact of HFHO, considering treatment costs, hospital stays, and healthcare resource utilization, as well as potential savings from reduced rehospitalizations and improved quality of life. Addressing these areas will provide a comprehensive understanding of HFHO's long-term efficacy and safety, which is essential for its integration into clinical practice.

In conclusion, nasal HFHO offers a promising alternative to conventional oxygen supplementation in managing hypoxemia and respiratory dysfunction in patients following Stanford Type B aortic dissection surgery. By improving oxygenation indices, reducing reliance on mechanical ventilation, and enhancing overall recovery, HFHO addresses key challenges in postoperative care. Future research should focus on identifying patient subgroups that benefit most from HFHO, exploring its mechanistic pathways in greater depth, and conducting randomized controlled trials to validate these promising findings and refine clinical protocols. The potential for HFHO to revolutionize both postoperative and broader respiratory care is substantial and warrants further rigorous exploration and implementation.

Disclosure of conflict of interest

None.

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