ORIGINAL ARTICLE

Dexmedetomidine Efficacy on Oxygenation During One Lung Ventilation in Thoracic Surgeries: A Prospective Randomized Controlled Study

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Abstract

Background: ***An established approach for thoracic procedures, one-lung ventilation (OLV) allows for more room in the thoracic cavity, which is necessary for the surgery. Improved oxygenation and resolution of hypoxemia during OLV are achieved with the use of dexmedetomidine and other methods.***

Aim: ***To determine if dexmedetomidine improves oxygenation during OLV and whether it is safe for patients having thoracic surgery.***

Subjects and methods: ***From October 2023 to March 2025, 104 participants participated in this prospective, randomized controlled trial. Two groups of patients were created: one that received maintenance with 2% sevoflurane (the S group) and another that received intravenous administration of Dexmedetomidine (0.3μg/kg) over a 10-minute period (the D group).***

Results: ***After 15, 30, and 45 minutes of lung isolation, PaO2 was considerably greater in the D group compared to the S group. When comparing the two groups after 15, 30, and 45 minutes of lung isolation, the PaO2/FiO2 ratio was substantially greater in the D group. After 15, 30, and 45 minutes of lung isolation, the PH values of the S Group were significantly lower than those of the D Group.***

Conclusion: ***Without affecting hemodynamic stability or postoperative recovery adversely, dexmedetomidine is an efficient and secure adjuvant for optimizing oxygenation during OLV.***

Keywords: Thoracic Surgery; Dexmedetomidine; Lung ventilation

1. Introduction

An established procedure during thoracic surgeries, one-lung ventilation (OLV) helps to create more room for the surgery and reduces contamination of the other lung while keeping the patient safe. The gold standard for OLV is general anesthesia accompanied by regulated mechanical breathing.[1]

The primary defense against hypoxemia is hypoxic pulmonary vasoconstriction (HPV), which occurs when blood flows from the unventilated parts of the lung to the ventilated ones, ensuring that the arterial blood flow is adequate. Variables such as alkalosis, vasodilators, anesthetic drugs, changes in pulmonary pressure, hypoxic pulmonary vasoconstriction, and others can affect this process.[2]

The immunomodulatory effects of volatile anesthetics are well-documented. Inhalational agents such as sevoflurane and isoflurane may have a protective effect against ALI due to their ability to reduce inflammatory markers, according to a small number of studies. In animal models, preconditioning with isoflurane decreased microvascular protein leakage and polymorphonuclear leukocyte recruitment to the lung. Additionally, the endothelial glycocalyx serves a protective function for volatile anesthetics. Propofol and other intravenous anesthetics have also been found to decrease inflammation in the lungs. Research has demonstrated that propofol can decrease the intrapulmonary shunt, which in turn reduces the likelihood of hypoxemia occurring during OLV.[3]

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The affinity of dexmedetomidine for α 2 receptors is eight times higher than that of clonidine, making it a selective agonist of α 2 receptors. Its analgesic, anti-inflammatory, sedative, and organ-protective effects are formidable as well. Reduced sympathetic tone, HR, BP, and myocardial oxygen consumption are the effects of dexmedetomidine. The impact of dexmedetomidine on OLV has been the subject of several studies in recent years, with wildly varying and often contentious conclusion.[4]

The purpose of this research was to determine whether dexmedetomidine improved oxygenation during OLV in patients having thoracic surgery and whether it was safe to use.

2. Patients and methods

After receiving approval from the committee at Al-Zahraa University Hospital prior to study initiation, 104 patients undergoing various elective thoracic surgeries were enrolled in this prospective randomised study. All patients, including those whose parents provided written consent because they were under the age of 21, were required to do so. The study ran from October 2023 to March 2025.

Inclusion criteria:

Age 18 to 65 years, BMI<35, and of either sex

Exclusion criteria:

Patient refusal, history of respiratory disease, e.g., chronic obstructive pulmonary disease (COPD), patients with advanced liver disease, patients on renal dialysis, pregnant women, patients with urgent thoracic surgery, ASA physical status more than III, heart block, suspect difficult airway, and intraoperative hypoxemia if SpO2 decreased below 85%.

Two equal groups of fifty-two patients each were assigned at random using a computer-generated randomisation sequence and sealed opaque envelopes: Dexmedetomidine (0.3µg/kg) was given intravenously over a 10-minute period in the D group, where maintenance was carried out using 2% sevoflurane. During the entire surgical process, a steady stream of dexmedetomidine (0.3µg/kg/h) will be administered after the bolus dose has been finished. The S group had maintenance with 2% sevoflurane.

Preoperative Assessment:

Patients were assessed one day before surgery and the following points were checked: history including assessment of the cardio-respiratory status, physical examination: including chest, heart and abdominal examination, airway assessment, routine laboratory investigations, chest x-ray and Electrocardiogram.

Pre-induction of anesthesia:

Upon reaching the operating room, the peripheral intravenous line was placed, and intravenous midazolam (50-100 µg/kg) was administered to all patients as a premedication. Continuous monitoring with noninvasive arterial blood pressure, pulse oximeter, and five-lead electrocardiogram. For invasive blood pressure monitoring, a radial artery was threaded into the forearm of the side opposite the surgical incision using local anaesthesia. The arterial blood gas (ABG) monitoring was also improved at various points throughout the procedure, including at room air, 5 minutes after intubation, 15 minutes after one lung ventilation, 30 minutes after one lung ventilation, 45 minutes after one lung ventilation, and 10 minutes after two lung ventilation.

Induction of anesthesia:

For three minutes, the patient was pre-oxygenated with 5L/min of oxygen, and the anaesthesia was induced with fentanyl 1-2µg/kg, propofol (1.5-2.5mg/kg), and atracurium 0.5mg/kg. After that, a double-lumen tube of the appropriate size was inserted into each patient (males: 39–41 F, females: 35–37 F), and the site was verified using auscultation and a fiberoptic bronchoscope (FOB). Tidal volume was set at 4-6 mL/kg based on optimal body weight after DLT insertion was confirmed. Respiratory rate was adjusted to maintain an end-tidal carbon dioxide (EtCO2) value between 35-40 mmHg, and minute volume and peak inspiratory pressure were set at normal values.

Maintenance:

D group:

In which maintenance was performed with 2% sevoflurane, Dexmedetomidine (0.3µg/kg was administered intravenously over 10 minutes. After completion of the bolus dose, a continuous infusion of dexmedetomidine (0.3µg/kg/h). The infusion continued throughout the operative procedure.

S group:

The maintenance dose of sevoflurane was 2%. Each group utilised the same two-lung ventilation (TLV) settings: volume-controlled ventilation, an ideal tidal volume (Vt) of 6 ml/kg, a fraction of inspired oxygen (FiO2) of 0.6, and an adjusted respiratory rate to maintain an end-tidal carbon dioxide (PE0 CO2) range of 35 to 42 mmHg.

Applying FiO2 1 to keep SaO2>92%, PEEP to the ventilated lung, and CPAP to the non-ventilated lung were the settings used during OLV. In order to resolve hypoxaemia (SpO2<90%), recruitment manoeuvres were carried out and constant positive airway pressure was applied to the non-operated lung.

To keep the diuresis above 0.5 mL/kg/h, crystalloid restrictive fluid therapy was given at a rate of 2 mL/kg/h.

When the diuresis rate was less than 0.5 mL

per kilogramme per hour, a 250 mL bolus of crystalloids was given.

Administering intravenous hydration or fentanyl as needed kept intraoperative arterial pressure within 20% of baseline control.

Assessment parameters:

Measurement of the investigated parameters was carried out before induction while breathing room air (preinduction) (T0), 5min after induction two-lung ventilation (T1), then at 15min of OLV(T2), 30min after start of OLV(T3), 45min after start of OLV (T4), and 10min after institution of two-lung ventilation(T5). Despite never having to use it, a central venous catheter (CVC) was sterilely implanted; a urinary catheter was inserted to monitor urine output during the procedure. The nasopharyngeal probe was also used to measure and track the patient's core body temperature.

Both groups underwent sufficient lung re-expansion using the recruit manoeuvre prior to operation completion. Hypoxia and acidity were also noted, as were any irregular heartbeats. Following surgery, the patient was sent to the postoperative care unit and the following postoperative parameters were noted: length of life in the intensive care unit, as well as the amount of time spent in the hospital.

The recorded parameters:

The following parameters are measured: arterial blood gas (ABG), heart rate (HR), mean arterial pressure (MAP), end tidal carbon dioxide (CO2), pulmonary problems observed after surgery, length of time spent in the intensive care unit (ICU), and overall hospital stay.

Sample Size:

A previous study was used to determine the mean difference in PaO2/FiO2 ratio between the dexmedetomidine group and the sevoflurane group, which was then used to calculate the sample size.[5] With a power of 80.0%, a 2-tailed test with an α error of 0.05, and an effect size of 0.557, the G power software version 3.1.9.4 was used to determine that each group needed a minimum of 52 samples.

Statistical analysis:

We used SPSS Inc.'s (Chicago, Illinois, USA) statistical software for the social sciences, version 23.0, to examine the recorded data. When the quantitative data had a normal distribution, it was shown as mean±standard deviation and range. On the other hand, variables that did not have a normal distribution were shown as median with inter-quartile range (IQR). Numbers and percentages were also used to represent qualitative characteristics. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to examine the data for signs of normality. To compare the two means, we utilised an independent-samples t-test for significance. For qualitative data, we used Fisher's exact test and a chi-square test where the predicted count in any cell was less than 5. Otherwise, we used the Chi-square test only when necessary. We allowed a 5% margin of error and put the confidence interval at 95%. This leads us to the following conclusion about the significance of the p-value: The results were deemed significant when the P-value was less than 0.05, very significant when the P-value was less than 0.001, and insignificant when the P-value was greater than 0.05.

Primary outcome:

Intraoperative oxygenation.

Secondary outcomes:

Critical care unit and hospital stays, intraoperative haemodynamics, and postoperative pulmonary problems.

3. Results

Table 1. Comparison of the D and S groups based on demographic information.

DEMOGRAPHIC DATA	D-GROUP (N=52)	S-GROUP (N=52)	TEST VALUE	P-VALUE	SIG.
AGE (YEAR)					
MEAN±SD	42.63±12.47	46.15±13.51	0.965	0.337	NS
RANGE	16-66	17-75			
SEX					
FEMALE	18(34.6%)	25(48.1%)	1.943	0.163	NS
MALE	34(65.4%)	27(51.9%)			
ASA CLASSIFICATION					
ASA I	6(11.5%)	10(19.2%)	3.226	0.601	NS
ASA II	46(88.4%)	42(80.8%)			
BMI					
MEAN±SD	25.28±3.69	25.64±3.47	0.318	0.752	NS
RANGE	18.9-29.7	19-30			
DURATION OF SURGERY (HR)					
MEAN±SD	3.64±1.02	3.11±0.87	1.392	0.167	NS
RANGE	1-12	1.5-6			

For Mean±SD, use the t-Independent Sample t-test; for Number(%), use the x2:Chi-square test or, if applicable, Fisher's exact test. NS: Not very important.

Based on demographic data, the D-group and S-group did not differ statistically significantly (p>0.05),(table 1).

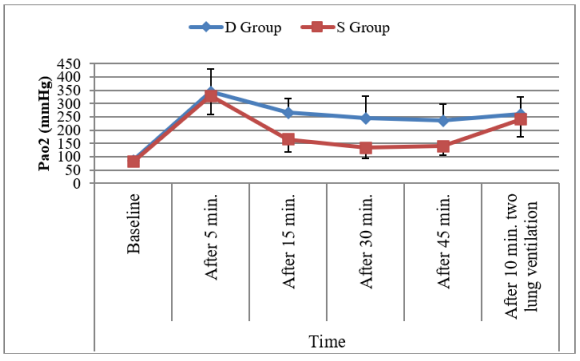

Figure 1. D-Group and S-Group comparison based on PaO2 (mmHg).

When comparing the D-Group and S-Group, the PaO2 values at baseline, five minutes after induction before lung isolation, and ten minutes after two lung ventilations showed no statistically significant differences (p>0.05); however, the D-Group had the highest statistically significant mean PaO2 (mmHg) value compared to the S-Group after fifteen, thirty, and forty-five minutes of

lung isolation (p<0.001),(figure 1).

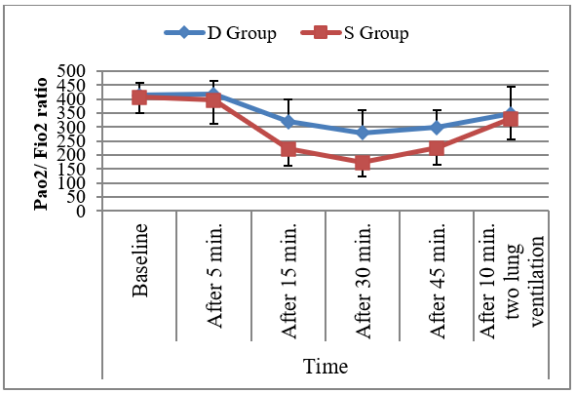

Figure 2. D-Group and S-Group comparison based on the PaO2/FiO2 ratio.

There was no statistically significant difference between the D-Group and S-Group in the PaO2/FiO2 ratio values at baseline, five minutes after induction before lung isolation, and ten minutes after two lung ventilations at the end of the operation (p>0.05). However, the D-Group had the highest mean PaO2/FiO2 ratio value compared to the S-Group after fifteen, thirty, and forty-five minutes of lung isolation (p<0.001),(figure 2).

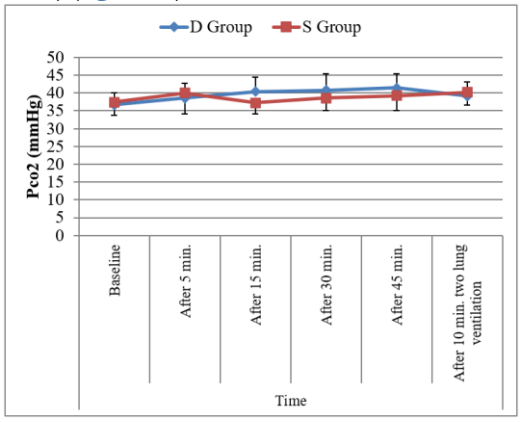

Figure 3. D-Group and S-Group comparison based on Pco2 (mmHg).

When comparing the Paco2 values at baseline, five minutes after induction TLV, after 15, 30, and 45 of OLV, and after ten minutes of two lung ventilations, there was no statistically significant difference between the D-Group and S-Group (p>0.05),(figure 3).

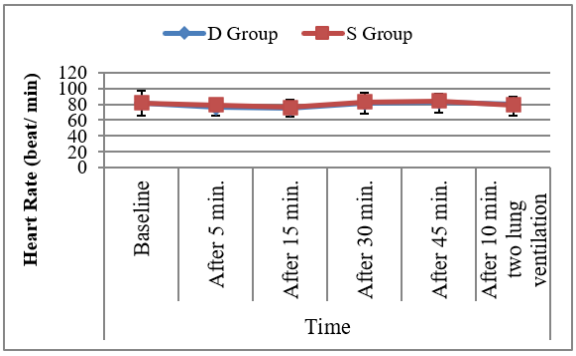

Figure 4. D-Group and S-Group comparison based on HR (beat/min).

The D-Group and S-Group were not different statistically significantly in terms of heart rate (beats per minute), as indicated by the p-value (p>0.05),(figure 4).

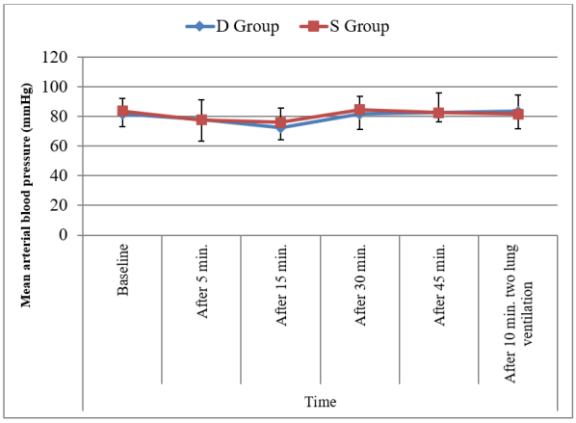

Figure 5. D-Group and S-Group comparison based on mean arterial blood pressure (mmHg).

There was no statistically significant difference between D-Group and S-Group according to mean arterial blood pressure (mmHg), with p-value (p>0.05),(figure 5).

Table 2. Comparing the D-Group and S-Group based on IUC stay and post-operative pulmonary complications.

POST-OPERATIVE PULMONARY COMPLICATION	D-GROUP (N=52)	S-GROUP (N=52)	TEST VALUE	P-VALUE	SIG.
BLEEDING	3(5.8%)	0(0.0%)	4.167	0.244	NS
DELAYED RECOVERY	12(23.1%)	9(17.3%)			
HYPOXIA	6(11.5%)	9(17.3%)			
NO COMPLICATIONS	31(59.6%)	34(65.4%)			
ICU STAY "DAYS"					
MEAN±SD	1.10±0.32	1.58±0.46	1.487	0.140	NS
RANGE	0-7	0-5			

For Mean±SD, use the t-Independent Sample t-test; NS stands for non-significant, S for significant, and HS for highly significant.

The D-Group and S-Group did not differ statistically significantly in terms of post-operative pulmonary complications (p-value: p>0.05), nor did they differ statistically significantly in terms of the number of "days" spent in the intensive care unit (p-value:p>0.05),(table 2).

4. Discussion

One lung ventilation (OLV) is considered as an established technique during thoracic surgeries, which helps in aiding the space for the surgery in the thoracic cavity and in minimizing the contamination of the other lung, without compromising the safety of the patient. General anesthesia with controlled mechanical ventilation is the preferred method during OLV.

Volatile anesthetics are known to have immunomodulating effects. Few studies have shown that use of inhalational agents like sevoflurane and isoflurane could attenuate the inflammatory markers and thus could have a

protective role against ALI.

Dexmedetomidine is a selective agonist of α 2 receptors whose tendency to α 2 receptors is eight times more than that of clonidine. It also has powerful sedative, analgesic, anti-inflammatory, and organ protective properties. Dexmedetomidine diminishes sympathetic tone, heart rate (HR), blood pressure, and myocardial oxygen consumption.

Statistical analysis of age, sex, ASA classification, body mass index (BMI), and operation duration did not reveal a difference between the D-group and the S-group in this study. After 15, After15,30, and 45 minutes of lung isolation, the pH values of the S-group decreased significantly relative to the D-group, according to the present study.

In the same line, Shi and Mi,[6] conducted a study with 120 senior patients who had thoracotomy with OLV; the patients were randomly assigned to either the D-group or the C-group. Prior to anaesthesia, patients in the D-group received 0.5 εg/kg/h of dexmedetomidine pumped into their veins. The patients in the control group received the same amount of normal saline via the pump. At times 2, 3, and 4, the pH of the D-group was found to be significantly higher than that of the C-group, according to their research.

The results showed that following15,30, and 45 minutes of lung isolation, PaO2 was considerably greater in the D-group than in the S-group.

In the same manner, Khddam et al.,[7] found that PaO2 decreased in both groups after OLV, the dexmedetomidine group maintained significantly higher PaO2 levels at later stage than placebo group.

In the same line, Shi and Mi,6 found that compared to the control group, the Dexmedetomidine group exhibited a significantly higher PaO2 at T2, T3, and T4.

On the other hand, Wang et al.[8] conducted a randomised controlled trial with 40 patients who needed OLV for thoracic surgery. The experiment was prospective, involved many centres, and used a parallel group design with single blinding. Under anaesthesia, patients were given either normal saline (N-Group) or continuous administration of dexmedetomidine (D-Group) at a rate of 0.75ug×kg-1 every 10-15 minutes. They found that arterial PaO2 declined when the OLV time was prolonged; nevertheless, there was no statistical significance between the D-Group and the N-Group at T0, T1, and T2. Possible explanations for this variation include variations in dexmedetomidine dosage.

The current study revealed that Paco2 was insignificantly different between D-group and S-group at baseline, 5min. after induction TLV, and after 15,30, 45 of OLV and after 10min two lung ventilation.

In the same line, Xia et al.,[9] researchers randomly assigned patients to one of two groups: one that received isoflurane and saline (NISO) and another that received isoflurane and dexmedetomidine (DISO) during elective thoracic surgery. In the DISO group, dexmedetomidine was infused at a rate of 0.7 μgkg−1h−1, while in the NISO group, saline was administered at a rate of 0.25 mL kg−1h−1. Intravenous remifentanil and inhalational isoflurane (20-2.0%) were used to maintain anaesthesia. The results showed no statistically significant differences in PaCO2 between the categories.

Also, Erturk et al.,[10] conducted a study with 44 patients who were randomly assigned to either the sevoflurane S-Group or the propofol P-Group, both of which had thoracic surgery with OLV. The S-Group underwent thiopental induction and sevoflurane maintenance with 1-2.5% in a 40/60% O2/N2O mixture. Propofol was used to induce anaesthesia in the P-Group, and remifentanil and propofol were infused to maintain the anaesthesia. When looking at pCO2 levels, they discovered no statistically significant changes between the two groups.

On the other hand, Asri et al.,[2] conducted research on 42 patients who were about to have a pulmonary venous angioplasty (PLV) under general anaesthesia with isoflurane inhalation. The patients were randomly assigned to one of two groups: one that would get an intravenous infusion of dexmedetomidine at a rate of 0.3 microgrammes per kilogramme per hour (DISO), and the other would receive an IV infusion of normal saline (NISO). According to their research, Dexmedetomidine significantly raised PaCO2 levels compared to the normal saline group. One possible explanation for this variation is the use of different doses of analgesics.

The results showed that after15,30, and 45 minutes of lung isolation, the PaO2/FiO2 ratio was considerably greater in the D-group than in the S-group.

This was supported by Huang et al.,[11] individuals undergoing thoracic surgery who were given dexmedetomidine (Dex) or a placebo during oxygenation-induced pulmonary shunt (OLV) were the subjects of a meta-analysis. They found that dexmedetomidine considerably raised PaO2/FiO2 compared to the placebo group.

In contrast to our result, Hüter et al.[12] conducted a study comparing the effects of sevoflurane and propofol during OLV on 54 individuals having elective thoracic surgery. To keep the patient under anaesthesia, doctors would use either sevoflurane (1 MAC) or propofol (3-6 mg/kg). They found no variation in oxygenation levels across the groups. This

variation could be a result of the use of certain medications.

Comparing the D-group and S-group according to HR, the current study found no statistically significant difference.

In the same line, Khddam et al.,[7] reported that HR was insignificantly different between dexmedetomidine and placebo groups.

Also, Buget et al.,[13] demonstrated that HR was insignificantly different between the dexmedetomidine and control groups.

In the same line, Khddam et al.,[7] reported that MAP was insignificantly different between dexmedetomidine and placebo groups.

Also, Buget et al.,[13] demonstrated that MAP was insignificantly different between the dexmedetomidine and control groups.

Furthermore, Kernan et al.,[5] showed that there was an insignificant difference in hemodynamic variables, MAP, between the dexmedetomidine and placebo groups.

In the same manner, Meng et al.,[14] conducted research on forty patients who opted to get a thoracoscopic lobectomy. One group of patients received dexmedetomidine (the "D-group"), while the other served as a control (the "C-group"). The D-group received an intravenous injection of 1μg/kg of dexmedetomidine (completed within 10 minutes) prior to induction; the S-group received an intravenous injection of 0.5μg/(kgh) until 10 minutes before the conclusion of the operation; and the C-group received an injection of the same quantity of normal saline. According to their findings, the two groups did not differ significantly in the incidence of postoperative pneumonia, acute respiratory distress syndrome, or pulmonary complications.

In contrast to our result, Lee et al.,[3] reported that dexmedetomidine had fewer postoperative pulmonary complications than the control group. This difference may be due to using different drugs and techniques.

4. Conclusion

Dexmedetomidine is an effective and safe adjunct for optimizing oxygenation during OLV without negatively impacting hemodynamic stability or postoperative recovery.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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