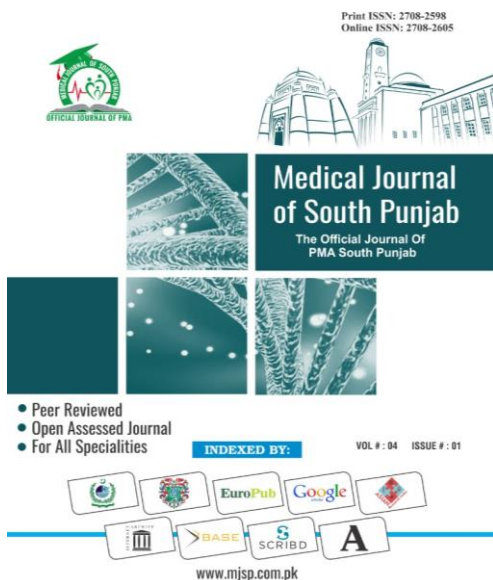


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Thoracoscopic surgery under epidural anesthesia for secondary spontaneous pneumothorax

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ABSTRACT

Objective: The aim of the study was to compare the outcomes of Thoracoscopic surgery for spontaneous pneumothorax when performed under epidural local anesthesia (ELA) versus under general anesthesia.

Methods: Prospective study was conducted at LUMHS Jamshoro, Pakistan over a 2-year period from 2019 to 2021, involving 180 patients who were randomly assigned using a computer-generated random number table. Patients aged 21–65 with ASA I and II classifications, diagnosed with pleural pathologies and scheduled for VATS procedures, were included in the study, with a restriction to a two-hour time limit.

Results: According to pulmonary lung functions, the mean FEV1/FVC, D_{LCO} and preoperative dyspnea score based on ATS was less in EA patients than GA patients, ($p < 0.001$). Whereas, underlying lung disease, COPD and ILD of GA and EA patients were almost equal, ($p > 0.050$). The mean operative time in GA and EA patients was 110.12 ± 13.92 minutes and 104.58 ± 7.86 minutes, respectively, ($p = 0.023$).

Conclusion: ELA exhibits advantages in terms of shorter global operating room time and a reduced incidence of related complications, highlighting its potential as a preferred approach for this procedure.

Keywords: Thoracoscopic surgery, Epidural anesthesia, Secondary spontaneous pneumothorax, General anesthesia, video assisted surgery

1. INTRODUCTION

Pneumothorax, initially described by Itard in 1803 and further elucidated by Laennec in 1819, is characterized by an accumulation of excess air in the pleural cavity¹. Surgical intervention remains paramount in its treatment, with the contemporary preference shifting towards video-assisted thoracoscopic surgery (VATS) over traditional open thoracotomies, marking advancements in surgical practice^{2,3}.

In practice, the double-lumen endotracheal tube is preferred during operations under general anesthesia (GA) for achieving single lung ventilation, deflating the operative lung to facilitate surgery while ventilating the contralateral side to maintain oxygenation levels for patients⁴. However, mechanical ventilation and muscle relaxants used during GA can lead to various adverse effects⁵, such as ventilator-induced lung injury, postoperative intractable cough, trauma to teeth, airway injuries, postoperative nausea and vomiting, increased risk of pneumonia⁶, impaired cardiac performance, and neuromuscular problems⁷.

The utilization of epidural and/or local anesthesia (ELA) has proven highly effective in addressing various challenges in thoracic surgeries⁷. Nezu et al^{7,8} conducted a groundbreaking study in 1997 and highlighted the efficacy of local anesthesia with sedation in wedge resection under VATS for spontaneous pneumothorax. Since then, ELA has become increasingly prevalent in managing a range of thoracic conditions, including pulmonary nodules, lung cancer⁹, pleurodesis for malignant pleural effusion, lung volume reduction surgery, tracheal reconstruction, and biopsy for anterior mediastinal masses¹⁰.

This study suggests that thoracoscopic surgery under epidural anesthesia could be a safer option for patients with secondary spontaneous pneumothorax compared to

general anesthesia. Clinicians may consider this approach particularly for patients who are not ideal candidates for general anesthesia due to comorbidities or other risks.

2. METHODOLOGY

Prospective randomized clinical study was conducted at Lady Reading Hospitals over a 2-year period from 2019 to 2021, involving 180 patients who were randomly assigned using a computer-generated random number table. Patients aged 21–65 with ASA I and II classifications, diagnosed with pleural pathologies and scheduled for VATS procedures, were included in the study, with a restriction to a two-hour time limit.

Patients with anticipated challenges in managing their airways, those experiencing hemodynamic instability, and individuals with persistent cough, elevated airway secretions, severe emphysema, or clinical signs of active infectious disease may require special considerations during medical procedures. Additionally, patients with hypoxemia ($\text{PaO}_2 < 60$ mmHg) or hypercarbia ($\text{PaCO}_2 > 50$ mmHg), coagulopathy ($\text{INR} \geq 1.5$), obesity ($\text{BMI} > 30$ Kg/m²), infection at the injection site, or allergies to local anesthetics should be approached with caution. Those with neurological disorders such as seizures, intracranial masses, or brain edema also warrant careful attention in medical interventions.

Patients in the anesthesia clinic underwent surgery only after giving informed written consent, and they were familiarized with the Visual Analogue Scale (VAS), a 10 cm straight line representing the spectrum from "no pain" to "worst pain." Anesthesia administration strictly adhered to the hospital protocol governing preoperative investigations, fasting hours, intraoperative monitoring, and drug use, with perioperative

records systematically recorded at fixed intervals for comparative analysis.

The study comprised two equal groups, each with 100 patients: the TEA Group, where awake patients received Thoracic Epidural Anesthesia, and the GA Group, where patients underwent General Anesthesia with one-lung ventilation. In the TEA group, patients were pre-medicated with 3–4 mg intravenous Midazolam and 50 mcg intravenous Fentanyl, followed by the insertion of an epidural catheter between T3 and T4 or T4 and T5 intervertebral spaces. A test dose of 5 ml of 2% Lidocaine was injected, followed by 7–10 ml of Bupivacaine 0.5% and 50 mcg of Fentanyl to achieve sensory and motor block between C7 and T7 levels, ensuring diaphragmatic respiration. Patients experiencing persistent hemodynamic instability or hypoxemia were converted to general anesthesia and excluded from the study. Hypoxemia was defined as peripheral oxygen saturation (SpO₂) < 92% on room air, necessitating oxygen supplementation (O₂ mask 5–7 l/min). Postoperatively, technical and logistic limitations led to the removal of the epidural catheter.

Patients undergoing general anesthesia were premedicated with Midazolam 3–4mg IV and Ondansetron 4mg IV. Anesthesia induction included Propofol (2 mg/kg) and Fentanyl (1 mcg/kg), followed by Cisatracurium 0.1 mg/kg IV for double-lumen endotracheal tube insertion, confirmed by fiberoptic bronchoscopy. Lung isolation techniques were employed to access the operative hemithorax, emphasizing lung protective ventilatory strategies such as low tidal volumes, moderate positive end-expiratory pressure (PEEP), and recruitment maneuvers.

Postoperatively, both groups received regular Paracetamol 1gm IV every 6 h for 48 h, with Pethidine 50mg IV as rescue

analgesia if the Visual Analog Scale (VAS) score was ≥ 3 .

Uniportal VATS procedures involve making an incision in the 8th intercostal space at the posterior axillary line without the need for gas insufflation; a wound protector is applied to induce open pneumothorax, facilitating deflation of the operated lung, and continuous communication with the surgical team ensures satisfaction and technical feasibility for accessing the operated hemithorax in the TEA group; intraoperatively, a shared decision was made in three patients to convert to GA due to either hemodynamic instability or technical difficulties for the surgeon in completing the procedure.

The data were analyzed using the Statistical Package for Social Science (SPSS) version 22.0, with quantitative results presented as mean \pm standard deviation (SD) and qualitative data expressed in terms of frequency and percentage.

3. RESULTS

Overall, 200 patients were included in this study, in which 165 (82.5%) patients underwent general anesthesia (GA) and 35 (17.5%) patients underwent epidural anesthesia. The mean age of GA and EA patients was 62.85 ± 9.28 years and 63.72 ± 7.62 years, ($p=0.833$). The mean preoperative chest tube drainage of GA and EA patients was 12.19 ± 4.28 days and 12.51 ± 4.32 days, ($p=0.689$). According to pulmonary lung functions, the mean FEV₁/FVC, D_{LCO} and preoperative dyspnea score based on ATS was less in EA patients than GA patients, ($p<0.001$). Whereas, underlying lung disease, COPD and ILD of GA and EA patients were almost equal, ($p>0.050$). (Table. I).

The mean operative time in GA and EA patients was 110.12 ± 13.92 minutes and 104.58 ± 7.86 minutes, respectively, ($p=0.023$). Whereas, pre and postoperative

chest tube drainage, length of hospital stay, VAS pain score, prolonged air leak, pneumonia, ARDS, empyema, hospital death and recurrences in GA and EA patients were almost equal, and the differences were statistically insignificant, ($p>0.050$). (Table. II).

N (%), Mean \pm SD, GA Z general anesthesia, EA Z epidural anesthesia

Table. I
Demographics and preoperative characteristics of the study groups

Characteristics	GA	EA	p-value
	165 (82.5%)	35 (17.5%)	
Age (years)	62.85 \pm 9.28	63.72 \pm 7.62	0.833
Gender			
Male	108 (65.5)	22 (62.9)	0.770
Female	57 (34.5)	13 (37.1)	
Preoperative chest tube drainage (days)	12.19 \pm 4.28	12.51 \pm 4.32	0.689
Pulmonary lung function			
FEV1/ FVC	64.91 \pm 6.91	21.55 \pm 2.88	<0.001
DLCO	68.21 \pm 7.62	24.87 \pm 2.28	<0.001
Preoperative dyspnea score based on ATS	1.78 \pm 0.42	3.04 \pm 0.22	<0.001
Underlying lung disease	5 (3.0)	2 (5.7)	0.433
COPD	142 (86.1)	34 (97.1)	0.067
ILD	30 (18.2)	14 (40.0)	0.065
N (%), Mean \pm S.D, GA= general anesthesia, EA= epidural anesthesia			

Table. II
Outcome distribution of the study groups

Outcome	GA	EA	p-value
	165 (82.5%)	35 (17.5%)	
Operative time (min)	110.12 \pm 13.92	104.58 \pm 7.86	0.023
Chest tube drainage (days)			
Preoperative	12.53 \pm 2.42	11.15 \pm 1.42	0.061
Postoperative	6.31 \pm 1.39	6.63 \pm 1.35	0.215
Hospital stay (days)	9.78 \pm 1.01	9.98 \pm 0.82	0.303
Pain score	3.35 \pm 1.48	3.51 \pm 1.29	0.560
Prolonged air leak	14 (8.5)	3 (8.6)	0.987
Pneumonia	14 (8.5)	0 (0.0)	0.074
ARDS	10 (6.1)	1 (2.9)	0.450
Empyema	9 (5.5)	1 (2.9)	0.522
Hospital death	7 (4.2)	2 (5.7)	0.703
Recurrence	28 (17.0)	7 (20.0)	0.668

4. DISCUSSION

Recent studies have recommended considering awake surgery for patients with concomitant lung diseases and high risks of postoperative complications from general anesthesia (GA), particularly in cases of surgical intervention for solitary pulmonary nodules (SSP)¹¹. Awake surgery under epidural anesthesia (EA) has been suggested as an alternative approach, with some articles reporting reduced recurrence rates and better outcomes in high-risk patients¹². This approach may also be applicable in cases involving various thoracic diseases, offering a potential solution for challenging surgical scenarios.

A systematic review and meta-analysis were conducted by Chen et al¹³ to assess the feasibility and safety of thoracoscopic surgery under epidural and/or local anesthesia for spontaneous pneumothorax and reported positive results in favor of epidural anesthesia. While Nezu et al⁷. suggested that epidural and/or local anesthesia (ELA) resulted in shorter operative times and postoperative hospital stays compared to general anesthesia (GA), Pompeo et al. did not confirm these findings. Similarly, while Nezu et al⁷. reported shorter postoperative hospital stays with ELA, Noda et al¹⁴ held the opposing view.

In this study mean operative time in GA and EA patients was 110.12 \pm 13.92 minutes and 104.58 \pm 7.86 minutes, respectively. Wu et al¹⁵ and Pompeo et al¹⁶ observed that the ELA (awake endotracheal intubation) group exhibited a shorter anesthesia induction time due to the omission of tracheal intubation and subsequent bronchoscopic examination, while the absence of muscle relaxants in this group facilitated quicker postoperative recovery and reduced surgical time.

In this study in hospital mortality was observed 4.2% in general anesthesia group and 5.7% in epidural group. Hospital stay was 9.98 ± 0.82 days in EA group and 9.78 ± 1.01 days in GA group. Ahn et al¹⁷ documented two hospital deaths within the ELA group, one attributed to destructive lung pathology caused by multiple huge bullae, leading to mediastinal shift, and the other linked to an underlying case of unusual interstitial pneumonia. According to Gonzalez-Rivas et al¹⁸ patients in the ELA group, as opposed to those receiving general anesthesia (GA), did not experience any additional security measures and were able to leave the hospital without incident within several days.

According to studies conducted by Dong et al¹⁹ and Liu et al²⁰, contraindications for thoracoscopic surgery under general anesthesia include American Society of Anesthesiologists (ASA) scores greater than 3, bleeding disorders, sleep apnea, obesity (body mass index > 30 kg/m²), extensive pleural adhesions, presence of epidural puncture contraindication, expected difficult airway management (such as airway hyper-reactivity), and tumors larger than 6 cm.

5. CONCLUSION

The study reveals that thoracoscopic surgery for spontaneous pneumothorax under epidural anesthesia (ELA) demonstrates feasibility and safety, as evidenced by similar operative time, hospital stay, complications, air leak, recurrence, and perioperative mortality compared to general anesthesia (GA). Notably, ELA exhibits advantages in terms of shorter global operating room time and a reduced incidence of related complications, highlighting its potential as a preferred approach for this procedure.

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