

Low Dose Intrathecal Morphine (ITM) in Cardiac Surgery Enhances Recovery After Surgery (ERAS)

Vivek Sharma¹, Hiteshi Aggarwal²

Abstract

The recently developed Enhanced Recovery After Surgery (ERAS) protocol underscores the critical need for effective postoperative pain management. Preoperatively, the use of single-shot low-dose intrathecal morphine (ITM) plays a pivotal role in ensuring adequate intraoperative and postoperative analgesia, thereby promoting early recovery and reducing the incidence of postoperative pulmonary complications. Here, we present two case reports where low-dose ITM was administered before induction, maintaining stable hemodynamics without any episodes of hypotension or bradycardia. However, the use of ITM in patients undergoing imminent heparinisation carries a risk of spinal hematoma, necessitating careful patient selection and timing of administration. Close monitoring for any neurological deficits is essential in this context. Postoperatively, both patients were early extubated without respiratory depression, and their Visual Analog Scale (VAS) scores remained between 0-2 in the first 24 hours and 2-3 up to 48 hours postoperatively. We advocate for the use of low-dose ITM (5-6 µg/kg) as a crucial component of multimodal analgesia to achieve robust postoperative pain relief in cardiac surgery, as these procedures typically entail significant pain during the initial 24 hours, triggering catecholamine release and increasing myocardial oxygen demand.

Keywords: Cardiac Surgery, Enhanced Recovery After Surgery (ERAS), Hemodynamic Stability, Intrathecal Morphine, Low-Dose ITM, Multimodal Analgesia, Postoperative Pain Control, Visual Analog Scale (VAS)

Introduction

Postoperative analgesia, both adequate and effective, is now a crucial part of the Enhanced Recovery After Surgery (ERAS) approach, because to the widespread use of early extubation protocols following heart surgery [1]. Cardiothoracic surgery patients typically have moderate to severe postoperative pain, with antero-lateral and postero-lateral thoracotomies (ALT and PLT, respectively) reporting more intense pain than midline sternotomies. A major contributor to postoperative morbidity and mortality in cardiac surgery is atelectasis and impaired lung function, exacerbated by inadequate postoperative pain relief. Delays in extubation, basal atelectasis, a decreased PaO₂/FiO₂ ratio, an extended intensive care unit stay, an increased incidence of delirium [2], chronic pain, and persistent postoperative pain (PPP) are all outcomes that can occur as a result of insufficient analgesia. [3]

A multimodal strategy, or balanced analgesia, is essential for optimum pain management before and after surgery. Intrathecal morphine (ITM) has been employed for decades. [4]. The utilization of intrathecal morphine (ITM) has been historically devalued due to a lack of accurate data and recommendations, despite the fact that it offers both intraoperative and postoperative pain management that is of exceptional quality. The purpose of this article is to give two case reports that demonstrate that a single low-dose infusion of intrathecal morphine (ITM) during heart surgery can provide significant

postoperative pain relief for up to 48 hours. This, in turn, reduces the surge in stress catecholamines and myocardial oxygen demand.

Case Report 1

A 50-year-old female, 60 kg weight, with rheumatic heart disease (RHD), severe mitral stenosis (MS), severe mitral regurgitation (MR), and atrial fibrillation (AF) with a heart rate of 120-150/minute, was planned for mitral valve replacement (MVR) surgery under cardiopulmonary bypass (CPB) and moderate hypothermia. The patient reported having palpitations and dyspnea (NYHA III) along with intermittent chest discomfort, pedal edema, orthopnea, and paroxysmal nocturnal dyspnea. The patient did not exhibit any symptoms of hemoptysis, transient ischemic attack, or stroke. The patient did not have any additional comorbidities.

Preoperative transthoracic echo suggested rheumatic heart disease, severe MS with a valve area of 1 cm² and a mean gradient of 11 mmHg, severe MR, severe pulmonary hypertension (PAH), and good biventricular function (BVF). Coronary angiography (CAG) revealed normal coronaries. Blood investigations showed hemoglobin 10 g/dl, platelet count 185,000/mm³, TLC 7,000 cells/mm³, serum creatinine 0.81 mg/dl, and INR 1.2. Preoperatively, the patient was on tablet Cardarone 200 mg BD, tablet Metoprolol XR 25 mg BD, tablet Dytor 10 mg BD, and tablet Warfarin 1 mg OD. Warfarin was stopped 5 days before surgery, and the coagulation

¹Department of Anaesthesia, Teerthanker Mahavir Medical College & Research Centre, Moradabad, Uttar Pradesh, India.

²Department of Anaesthesia and Intensive Care, Post Graduate Institute of Medical Education and Research, Chandigarh, India.

Address of Correspondence

Dr. Vivek Sharma,

Department of Anaesthesia, Teerthanker Mahavir Medical College & Research Centre, Moradabad, Uttar Pradesh, India.

E-mail: Officer.sharma@gmail.com

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profile was repeated a day before surgery.

Intraoperatively, after attaching standard monitors, a 16 G IV cannula was placed, and ultrasound (USG)-guided arterial line (20 G) was secured in the left radial artery for invasive BP monitoring. Baseline vitals were: IBP 110/78 mmHg, HR 100-130/min (AF), and SpO₂ 98%. Under aseptic precautions, 350 µg morphine and 20 µg fentanyl in 6 ml normal saline were administered intrathecally with a 26 G Quincke's spinal needle at the L3-L4 space. Following spinal anesthesia, there was no episode of hypotension, with MAP >70 mmHg. Induction was done according to institutional protocol including injection propofol 1.5 mg/kg, injection midazolam 0.05 mg/kg, 2 µg/kg fentanyl and injection vecuronium 0.1 mg/kg was given at induction. Patient's airway was secured through endotracheal intubation, followed by mechanical ventilation. Anesthesia was maintained with vecuronium and isoflurane (MAC 1). Following induction and intubation, a femoral arterial line was placed in the left femoral artery to allow for continuous blood pressure monitoring and arterial blood gas sampling throughout the surgery. Additionally, a 7 French (Fr) central venous catheter was inserted via the left internal jugular vein (IJV) to provide central venous access for fluid administration, medication delivery, and central venous pressure (CVP) monitoring, which is essential for guiding fluid management and assessing cardiac function during the procedure. There was no significant hypotension, with the mean arterial pressure (MAP) maintained above 65 mmHg and the heart rate (HR) stable between 80-90 beats per minute. A median sternotomy is performed and cardiopulmonary Bypass (CPB) was established according to institutional protocol after achieving an ACT >480 seconds. There was no haemodynamic disturbance observed for instance increase in mean arterial pressure (MAP) or heart rate (HR) during key surgical phases, including incision, sternotomy, sternal retractions, and cannulations. This stability indicates that the analgesia provided was adequate, effectively managing the patient's pain and stress responses throughout these critical moments of the procedure. The total aortic clamp time (AXC) was 90 minutes, while the cardiopulmonary bypass (CPB) time was 120 minutes. Following mitral valve replacement (MVR), transesophageal echocardiography (TEE) study revealed following cardiac parameters a mean gradient of 2.5 mmHg across the mitral valve, no paravalvular regurgitation, no prosthetic mismatch, mild TR, LVOT VTI 13 cms, and good biventricular (BV) function. The patient was weaned off cardiopulmonary Bypass (CPB) with mean arterial pressure (MAP) >70 mmHg, heart rate (HR) 70/min with normal sinus rhythm (NSR), and a vasoactive inotropic score (VIS) of 8. A vasoactive inotropic score (VIS) of 8 indicates a moderate level of support required to maintain hemodynamic stability in the patient. The VIS is calculated based on the types and doses of vasoactive and inotropic medications administered, providing a quantitative measure of the pharmacologic support for cardiac function. A score of 8 suggested that the patient required close monitoring and possible adjustments in treatment to optimize cardiac performance and maintain adequate perfusion. Pericardial and right pleural drains were inserted.

Postoperatively, in the ICU, the patient was weaned off the ventilator and extubated after 2.5 hours, with stable vitals (MAP >70 mmHg, HR 70/min NSR, RR 18/min) and no respiratory depression. The

patient was started on injection paracetamol 1 gm QID and injection ondansetron 4 mg TDS. Pain scores at rest and on coughing were measured using a visual analogue scale (VAS score 0 to 10) every 3 hours during the first 24 hours and every 12 hours during the next 48 hours. The VAS score was 0 for the first 24 hours, 1-3 at 36 hours, and 1-3 at 48 hours postoperatively. The VAS score was maintained at 1-3 until 72 hours postoperatively. The patient was comfortable doing incentive spirometry and mobilizing. A postoperative PaO₂/FiO₂ ratio greater than 300 was maintained, indicating adequate oxygenation. Additionally, the patient was pain-free during incentive spirometry, which facilitated effective lung expansion, and early mobilization was observed, contributing to overall recovery and reducing the risk of postoperative complications. The patient had no episodes of respiratory depression, nausea/vomiting, or urinary retention and was discharged from the ICU on 4th Post operative day.

Case Report 2

A 20-year-old male, weighing 40 kg and standing at 165 cm, was involved in a road traffic accident resulting in chest trauma with a left clavicular fracture, contusion, abrasion, and a massive loculated hemopneumothorax on the left side, primarily managed with a left intercostal drainage tube (ICD) and other supportive measures. Since the patient's condition was worsening, characterized by ongoing tachypnea, breathlessness, tachycardia, and diaphoresis, the decision was made to schedule a video-assisted thoracoscopic surgery (VATS) for the management of massive hemopneumothorax and clot retrieval from the left pleural cavity. This minimally invasive approach allows for effective drainage and management of the loculated hemopneumothorax, addressing the underlying issues and improving respiratory function. The patient was scheduled for surgery using video-assisted thoracoscopy surgery (VATS) with one lung ventilation (OLV). Preoperative imaging including HRCT chest and chest X-ray revealed a massive loculated hemopneumothorax causing compression atelectasis of the left lung parenchyma with the left ICD in situ. Preoperative cardiac status evaluation through transthoracic 2D-echocardiography indicated good biventricular functions (BVF), no evidence of pericardial effusion with no other abnormalities. His breath-holding time (BHT) was greater than 28 seconds. Laboratory investigations showed hemoglobin level of 12 gm/dl, platelet count of 1.85 lakhs/mm³, TLC of 9500 cells/mm³, serum creatinine of 0.71 mg/dl, and INR of 1.2.

During the procedure, ASA recommended standard monitors were attached to continuously assess vital signs, and a 16 G intravenous cannula was secured for rapid fluid administration and medication delivery. An arterial line was placed in the left radial artery for invasive blood pressure monitoring. The baseline vital signs were recorded as an invasive blood pressure (IBP) of 120/78 mmHg, a heart rate (HR) of 90 beats per minute, and an oxygen saturation (SpO₂) of 98% on room air, indicating stable hemodynamics and adequate oxygenation prior to the procedure. Under aseptic precautions, intrathecal morphine (ITM) was administered with 250 µg morphine and 20 µg fentanyl in 6 ml of normal saline using a 26 G Quincke's spinal needle at the L3-L4 space in a sitting position. There were no episodes of hypotension observed at this juncture with maintained mean arterial blood pressure (MAP) > 65 mmHg subsequently. Induction was

performed according to institutional protocol including injection propofol 1.5 mg/kg, injection midazolam 0.05 mg/kg, 2 µg/kg fentanyl and injection vecuronium 0.1mg/kg was given at induction. Patient's airway was secured through endotracheal intubation, followed by mechanical ventilation. with 2 µg/kg of fentanyl. After induction (DLT) or double lumen endotracheal tube tube was inserted using a laryngoscope to visualize the vocal cords and carefully inserted the DLT into the trachea, angling it towards the side being intubated. The tube was advanced until it reaches approximately 29 cm at the lip, and its position was confirmed through auscultation and capnography. The patient was intubated with a 37 French double-lumen tube (DLT) and secured at 29 cm after confirming DLT position. A 7 French triple-lumen central line was inserted via the left internal jugular vein. Anesthesia was maintained with vecuronium and isoflurane (MAC 1) and one lung ventilation (OLV) was initiated with collapse of the left lung. The patient maintained stable hemodynamics and SPO₂ at 98% with 50% FIO₂. There were no significant episodes of hypotension, with the mean arterial pressure (MAP) maintained above 65 mmHg and the heart rate (HR) stable between 75-80 beats per minute. Additionally, there was no increase in MAP or HR during the subxiphoid incision, pleural manipulation, and clot evacuation, indicating that the analgesia provided was effective in managing pain and minimizing stress responses throughout the procedure. Occasional ventricular ectopics occurred during heart manipulation and compression. Following video-assisted thoracoscopic surgery (VATS), the patient's hemodynamics remained stable, with a mean arterial pressure (MAP) above 70 mmHg and a heart rate of 70 beats per minute in normal sinus rhythm (NSR), all without the need for inotropic support. Left pleural drains were inserted to facilitate fluid drainage, and double lung ventilation was resumed to ensure adequate respiratory function. The patient was reversed with neostigmine at a dose of 50 µg/kg and glycopyrrolate at 10 µg/kg, and extubation was successfully performed in the operating room. Post-extubation, the patient maintained stable vital signs, with a mean arterial pressure (MAP) greater than 70 mmHg, a heart rate of 70 beats per minute, and an oxygen saturation (SpO₂) of 98% on 3 L/min of supplemental oxygen. There were no signs of respiratory depression, and the patient reported a visual analogue scale (VAS) pain score of 0, indicating effective pain control.

In the postoperative period in the ICU, the patient received intravenous paracetamol at a dose of 1 gm four times a day and ondansetron at 4 mg three times a day. Pain scores at rest and during coughing were monitored using the visual analogue scale (VAS) every 3 hours for the first 24 hours and every 12 hours for the subsequent 48 hours. The VAS score remained at 0 for the first 24 hours, increased to 1-2 at 36 hours, and increased up to 3 at 48 hours postoperatively, maintaining between 3-4 until 72 hours postoperatively. The patient was comfortable during incentive spirometry and mobilization, with a PaO₂/FiO₂ ratio greater than 300 and no signs of basal atelectasis or respiratory depression. There were no incidents of nausea, vomiting, or urinary retention, and the patient was successfully discharged from the ICU on postoperative day 3.

Discussion

Etiology of acute surgical pain in cardiac surgery are

thoracotomy/sternotomy, incision, rib cage-related trauma, rib cage retraction related osteoarticular hypermobility, cutdown for vessel cannulation and harvest, chest tube entry sites, and pleural irritation, and muscle spasm from surgical positioning [4]. Inadequate intra and postoperative analgesia has been linked to pathophysiologic changes across all major organ systems, causing inflammation, unstable hemodynamics (tachycardia, hypertension, and vasoconstriction), adverse metabolic (increased catabolism), immunological (depressed immune response), and hemostatic (platelet activation) alterations which in turn may cause substantial morbidity, including myocardial ischemia and chronic pain syndromes [5]. The level of acute pain often peaks in the first 24 hours following surgery and gradually decreases over the course of the following week [6].

For decades, pain management in cardiac surgery has relied on high-dose intravenous opioids due to their cardiovascular stability. However, high-dose intravenous opioids are directly linked to respiratory depression and delayed extubation, which can result in prolonged ICU stays and increased risk of delirium. This has prompted a shift towards multimodal analgesia strategies that minimize opioid use while effectively managing pain. However, intrathecal morphine (ITM) provides intense analgesia for 24 hours and extended analgesia till 48 hours postoperatively and enhances early extubation and recovery [7]. Previous studies have confirmed better pulmonary function, including peak expiratory flow rate (PEFR) with intrathecal morphine (ITM), thus reducing incidence of basal atelectasis [4].

Due to the lack of evidence on the linear dose responsiveness of intrathecal morphine (ITM), a wide range of doses, from 0.1 mg to 4 mg, has been utilized in clinical practice. This variability reflects the uncertainty surrounding the optimal dosing for effective analgesia while minimizing potential side effects. Previous studies have reported increased incidence of respiratory depression with high dose ITM [8]. Current studies have advocated successful analgesia without any respiratory depression with low dose of 0.1-0.5 mg [8]. In our case reports, we report a successful analgesia postoperatively and early extubation without respiratory depression with low dose of 5-6 µg/kg ITM. Intense analgesia was achieved, with a visual analog scale (VAS) score of 0-2 persisting for the first 24 hours postoperatively. This was followed by scores of 1-3 until 36 hours and 3-4 until 48 hours postoperatively. As a result, the patient experienced no pain during incentive spirometry, facilitating early mobilization and contributing to an earlier discharge from the ICU. Intrathecal morphine (ITM), with very low dose 5-25 µg fentanyl enhances the analgesia with onset time of <10 minutes [8].

Intrathecal administration of morphine has always posed challenges for anesthesiologists worldwide due to its association with spinal hematoma in cardiac surgery, particularly related to heparinization. However, studies have reported a minimal incidence of spinal hematoma at a rate of 1 in 3,610. Additionally, allowing more than 60 minutes between spinal anesthesia and heparinization further reduces the risk of developing a spinal hematoma, making this approach safer for patients undergoing cardiac procedures [10]. Additionally, it's essential to consider the findings from a national review in Finland [11] which reported a rare incidence of neuraxial hematoma after

spinal block at 1 in 775,000. This risk significantly escalates, becoming 214 times higher in cases of imminent heparinization, underscoring the critical need for a comprehensive risk-benefit discussion in such scenarios.

Major side effects of ITM have been reported to be respiratory depression. Incidence of which, decreases with as dose as low as 0.1 – 0.5 mg but it mandates aggressive monitoring and oxygenation postoperatively for at least 24 hours.

Conclusion

Low-dose intrathecal morphine (ITM) for intra- and postoperative analgesia is cost-effective, easy to administer, and carries a low risk of

complications, facilitating stable hemodynamics throughout the procedure and in the postoperative period. In contrast to previously utilized higher doses of morphine, which often led to increased side effects such as respiratory depression and prolonged sedation, low-dose ITM promotes early extubation and recovery while minimizing these risks. Additionally, low-dose ITM reduces surges in catecholamines and lowers the risk of myocardial ischemia after surgery, making it a safer alternative for postoperative pain management.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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