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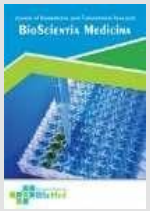

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The Role of Invasive Hemodynamic Monitoring in Patients with Severe Mitral Regurgitation Undergoing Herniorrhaphy Operation

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A B S T R A C T

Background: Mitral regurgitation (MR) indeed presents challenges during noncardiac surgeries, especially as the severity of MR tends to increase with age and poses a higher risk of perioperative complications. Accurate hemodynamic monitoring becomes crucial in these cases to manage potential complications effectively. However, the standard monitoring in MR conditions during operation, such as TEE, is not always available, but there are other options for invasive monitoring, such as arterial lines, which provide accurate hemodynamic monitoring. **Case presentation:** A 64-year-old, male, presented with Reponible Lateral Inguinal Hernia with comorbid of severe mitral and tricuspid regurgitation alongside congestive heart failure. The patient was premedicated with fentanyl 25 mcg intravenously, followed by oxygen supplementation with 3 lpm nasal cannula and insertion of the arterial line. Anaesthesia was performed using a lumbar epidural technique, with the insertion of an epidural catheter in the L1-L2 intervertebral space, Reponible Lateral Inguinal Hernia. The local anesthesia agent chosen was plain bupivacaine with a concentration of 0.5% and a volume of 8 ml. The onset of action of epidural anesthesia is achieved within 20 minutes as long as the operation reaches a total blockade as high as T8. The patient is monitored with standard monitors and an artery line during surgery. There were no complaints of shortness of breath, chest heaviness, or chest pain felt by the patient during the operation. **Conclusion:** Epidural anesthesia technique can provide stable hemodynamics in patients with severe mitral-tricuspid regurgitation and congestive heart failure and hemodynamic monitoring plays an important role postoperatively to prevent further deterioration and maintain stability.

1. Introduction

Mitral regurgitation (MR) is a prevalent valvopathy that affects a significant number of American adults. It occurs when the mitral valve fails to close properly, leading to the backward flow of blood into the left atrium during ventricular systole. This condition can result in various symptoms and complications, including heart failure. Therefore, understanding the implications of MR in the perioperative setting is crucial, as it increases the risk of morbidity and mortality. Population-based studies have revealed that approximately 30 million people in the United States undergo noncardiac surgery each year. Among this population, the presence of significant valvular heart disease, particularly MR, poses a substantial risk during the perioperative period.[1] The Framingham Heart Study indicates that the prevalence of MR increases with age, with 19% of adults having at least mild MR and 1-2% having moderate or greater MR. The impact of MR on surgical outcomes can be attributed to several factors. Firstly, the regurgitant flow of blood can lead to left atrial dilation and subsequent atrial.[2,3]

The 2014 American College of Cardiology (ACC) and American Heart Association (AHA) guidelines on perioperative cardiovascular evaluation and management highlight the increased risk of

perioperative cardiovascular complications in the presence of moderate-to-severe or severe MR. It is crucial to assess the severity of MR and consider it in the preoperative risk evaluation for patients undergoing noncardiac surgery. Anesthetic management plays a vital role in the perioperative care of patients with MR.[1] The selection of anesthesia should be based on a thorough assessment of the patient's overall health, the nature of the surgical procedure, and the potential impact on cardiovascular function.[1,3] Intraoperative monitoring plays a crucial role in assessing and managing hemodynamic parameters during surgical procedures. Hemodynamic instability can occur due to various factors, such as changes in blood volume, vascular resistance, or cardiac function. Continuous monitoring of key parameters like blood pressure, central venous pressure, and cardiac output allows anesthesiologists to promptly respond to any fluctuations and make necessary adjustments to the anesthetic plan.[3,5]

Blood pressure is one of the primary indicators of hemodynamic stability. During surgery, alterations in blood pressure can occur as a result of anesthesia, surgical stimuli, or patient-specific factors. By continuously monitoring blood pressure, anesthesiologists can swiftly identify hypotension or hypertension and take appropriate measures to correct it. These interventions may include adjusting the anesthetic depth and administering intravenous fluids or vasopressor medications.[4] In terms of preoperative preparation and monitoring of patients with severe MR, intraoperative TEE (transesophageal echocardiogram) is indicated to establish the anatomic basis for primary MR, especially in mitral intervention operations. However, TEE is not always available in several hospitals, and there are other options for minimally invasive monitoring, such as arterial lines.[1,3,4]

2. Case Presentation

A 64-year-old male presented with symptoms of a lump in the crease of his right thigh for the last 5 months. The lump was said to appear when walking or doing activities and would decrease when sleeping. This condition was later diagnosed as reponible lateral inguinal hernia. The elective hernioplasty operation was planned to be performed on this patient. The patient had a history of heart disease in the past 20 years and received routine treatment with warfarin, ramipril, bisoprolol, and furosemide. The patient also complained of other symptoms, such as tightness when lying down and having to use 2 pillows while sleeping, but there are no complaints of shortness of breath in mild activities, chest palpitations, chest pain, or leg swelling. The patient has no history of other comorbid diseases or allergies. The patient then underwent a series of examinations.

The patient stopped Warfarin consumption 8 days before the operation, and ramipril was stopped 24 hours before the operation. The INR result was normal, 0.99. In the preoperative examination, the patient's vital signs are GCS E4V5M6, blood pressure 120/90 mmHg, heart rate 67-76 times per minute, irregular, respiratory rate 20-22 times per minute, and SpO_2 97% room air. The physical examinator found a pan-systolic murmur, no rhonchi, no wheezing, and no leg edema. The electrocardiography (ECG) presents atrial fibrillation rhythm with normal response, and the echocardiography examination shows severe mitral and tricuspid regurgitation with high probability pulmonary hypertension and moderate hypokinesis along with decreased function of left ventricle diastolic and right ventricle diastolic with ejection fraction 36.7%. The thorax roentgen showed a patient with a cardiac thoracic ratio CTR) of 80%.

There are several preparations in the operating room to perform standard monitoring of the patient. NIBP, EKG, and pulse oximetry, installation of invasive blood pressure monitoring (artery line), preparation of vasopressor and inotropic drugs and antiarrhythmic drugs. Upon arrival to the operating room, the patient was premedicated with fentanyl 25 mcg, followed by oxygen supplementation 3 lpm nasal cannula. Epidural anesthesia was performed using a lumbar epidural technique, with the insertion of an Epidural catheter at the L1-L2 intervertebral space, targeting

the T11-L1 dermatome and T10-L1 target of the viscerotome. The local anesthetic agent chosen was plain bupivacaine with a concentration of 0.5% volume of 8 ml, incremental dose. The onset of action of epidural anesthesia is achieved within 20 minutes.

During the operation, the total blockade reached T8. Heart rate in atrial fibrillation patients with pulse fluctuations of 68-88 beats per minute, mean arterial pressure 60- 104 mmHg, and monitored oxygen saturation of 90-100%. During the operation, the patient received norepinephrine titration to stabilize MAP and blood pressure to prevent intraoperative complications. The hernoplasty procedure was performed in the supine position for 90 minutes duration. The bleeding was around 30 ml. Postoperatively, the patient was treated in the ICU for 1 day, followed by treatment in the room of high care before stepping down to the surgery ward. On the fourth day of postoperative care, the patient was discharged.

3. Discussion

Anesthesiologists can expect to routinely encounter patients with significant MR and emphasize a thorough understanding of the etiology, pathophysiology, hemodynamic goals, and basic considerations associated with valve pathology. The passage stresses the importance of creating an individualized perioperative patient care plan. This plan should be based on factors such as the etiology and severity of mitral regurgitation, the presence of other patient comorbidities, the risks associated with the surgical procedure, and the preferences of the patient.[1,5] In this case, a patient with mitral and tricuspid regurgitation along with congestive heart failure with low ejection fraction undergoes hernioplasty operation under epidural anesthesia.

The 2014 American College of Cardiology (ACC) and American Heart Association (AHA) guidelines on perioperative cardiovascular evaluation and management highlight the increased risk of perioperative cardiovascular complications in the presence of moderate-to-severe or severe MR. The guidelines recommend the routine intraoperative use of TEE during noncardiac surgery to diagnose cardiac abnormalities or monitor myocardial infarction in patients without risk or risk factors for hemodynamics, major pulmonary, or neurological problems.[1-3] It could provide the measurement of regulated biventricular and valve function, the structure of the heart, the extracardiac space, and the pulmonary aorta. However, the presence of TEE is rare in many settings and centers. There are few other invasive monitoring methods, such as arterial lines, that provide accurate hemodynamic monitoring.[1,2,6]

There are several anesthesia techniques in the management of anesthesia for patients with valvulopathy. Neuraxial anesthesia, specifically epidural analgesia, has been considered a favorable option for patients with significant mitral regurgitation (MR) undergoing surgical procedures as suggested in the 2014 American College of Cardiology (ACC) and American Heart Association (AHA) guidelines on perioperative cardiovascular evaluation and management.[1,7,8] Consequently, it is crucial to avoid myocardial depressants, such as volatile anesthetics, during anesthesia administration. One concern regarding neuraxial anesthesia is the potential occurrence of epidural hematoma, especially in patients receiving anticoagulant treatment.[8,9]

Anesthesia management highlights the safety and efficacy of graded epidural anesthesia in patients with severe mitral regurgitation along congestive heart failure conditions. Due to the complex condition of the heart, perioperative goals, in this case, include 1) maintaining hemodynamic stability, 2) preventing ischemic attack and acute heart failure, 3) maintaining flow and cardiac output by minimizing the regurgitant volume and supporting ventricular contractility.[7-10]

Systemic vascular resistance (SVR) holds a crucial role in determining the efficiency of ventricular ejection and the occurrence of regurgitation. An increase in SVR leads to greater impedance to ventricular ejection, which can result in an increased amount of regurgitation.[4,11] Thus, it is important to

avoid steep rises in afterload and sustained hypertension that could contribute to an elevation in SVR. When SVR is elevated, the heart has to work harder to overcome the resistance and eject blood into the systemic circulation. This increased workload can lead to an augmentation of regurgitation as the ventricles struggle to empty effectively.[5,11] The regurgitant fraction, which represents the proportion of blood flowing back into the chamber during diastole, may rise due to the increased pressure gradient created by the elevated SVR. To prevent inadequate myocardial perfusion, it is essential to maintain SVR.[12,13]

Euvolemia, the state of maintaining adequate blood volume, is crucial in clinical settings to prevent complications such as ventricular distension and worsening of mitral regurgitation (MR).[12] Aggressive volume resuscitation, although sometimes necessary, carries the potential risk of adverse effects on cardiac function. Therefore, it is important to optimize any underlying conditions that may increase the risk of arrhythmia and be prepared to manage new-onset perioperative atrial fibrillation (AF) with appropriate interventions.[4,5]

The focus of maintaining euvolemia lies in balancing the need for adequate fluid volume with the potential risks associated with excessive fluid administration.[5] In patients at risk for ventricular distension and MR worsening, a cautious approach to fluid management is warranted. Ventricular distension occurs when there is an excessive volume load on the heart, leading to impaired diastolic. Due to complicated heart conditions and function, invasive monitoring is essential to provide actual and accurate hemodynamic monitoring.[11,12] The standard monitoring for MR and TR is TEE, but TEE is not always available. TEE provides a high-quality assessment of mitral and prosthetic valves, including the definition of intracardiac masses and possible associated other abnormalities like thrombus, which could be performed pre-operation and intraoperative. However, other alternatives provide accurate hemodynamic monitoring, in this case, the arterial line has proved its effectiveness in invasive monitoring in MR patients.[1,4,5]

In cases where patients have both MR and AF, the decision to continue or interrupt oral anticoagulation during a surgical procedure should weigh the risk of thromboembolism against the risk of increased bleeding. Maintaining uninterrupted warfarin therapy during the periprocedural period might be considered for low bleeding-risk procedures, especially in patients at high risk for thromboembolism. Studies have suggested that uninterrupted warfarin therapy, particularly targeting a lower international normalized ratio (INR) goal of 2.0, may not significantly increase the risk of bleeding for many procedures and surgeries. However, it's crucial to approach each case individually, considering the specific patient's medical history, the type of surgery or procedure planned, and other relevant factors.[14] While uninterrupted anticoagulation may be suitable for some patients, for others, bridging therapy or specific adjustments to anticoagulation protocols may be necessary. Ultimately, the goal is to strike a balance between reducing the risk of thromboembolic events and minimizing the risk of bleeding complications during the perioperative period in patients with both MR and AF. It suggests avoiding bridging therapy for patients at low or moderate risk for thromboembolism unless there are additional individualized risks present, such as existing left atrial appendage thrombus or active cancer.[14-15] In the Preoperative period bridging therapy begins with discontinuing warfarin several days before surgery (typically five days before). Depending on renal function, initiate subcutaneous LMWH or UFH at therapeutic doses 3 days before surgery and discontinue LMWH 24 hours before surgery or 4 to 6 hours before surgery if UFH is being used. In the postoperative period, if there are no unexpected surgical issues that would increase bleeding risk, restart warfarin 12 to 24 hours after surgery. In cases where preoperative bridging therapy was administered due to high thromboembolic risk and the patient underwent a minor surgical procedure, resume LMWH or UFH 24 hours after surgery.[15]

Pulmonary hypertension is a common complication in patients with chronic functional mitral regurgitation (MR), primarily due to both systolic and diastolic left ventricular (LV) dysfunction. The presence of pulmonary hypertension further exacerbates the course of these conditions and may lead to right heart failure (HF).[5,13] Therefore, it is essential to adopt a comprehensive approach to managing this complex scenario. In addition to addressing the factors that worsen MR, such as optimizing medical therapy and considering surgical intervention when necessary, the avoidance and prompt correction of hypercarbia, hypoxia, and acidosis.[11,13]

In patients who exhibit signs of poor or acutely worsening cardiac output (CO), the initiation of inotrope therapy may be necessary. The selection of an appropriate inotrope should be based on the patient's overall clinical presentation and other comorbidities.[5,16] Inodilators such as milrinone or dobutamine are often considered due to their attractive properties in increasing contractility and reducing systemic afterload. However, the choice of inotrope may vary depending on the patient's specific hemodynamic profile.[5,11,12]

In this case, the management from pre-operation preparation according to the guidelines had been performed. The patient already went through several tests, including thoracic echocardiography to assess heart condition, discontinuation of the warfarin 8 days before the operation, discontinuation of anti-diuretic (spironolactone and furosemide) and ramipril 24 hours prior, and continuing beta-blocker before the operation, to reduce low blood pressure condition intra operation and maintain the heart rate, especially in AF rate. However, the discontinuation of warfarin in this case should be reconsidered since the risk of bleeding in such procedures is low, and the risk of a thromboembolism event is high. INR was at a normal level, which means the warfarin should be discontinued before the operation, or starting bridging therapy might be an option.

The patient was in a stable condition of blood pressure without any symptoms of acute heart failure. The operation procedure was less bleeding procedure, and the epidural procedure was relatively safe. The CVC and arterial line insertion were installed before the epidural procedure to present accurate monitoring of hemodynamics. From the guidelines, the use of TEE during surgery is a routine procedure but the patient still requires precise and accurate monitoring, especially after delivery of the epidural. In this case, arterial lines have been selected to provide such accuracy. In this case, the arterial lines give real-time hemodynamic monitoring. Epidural anesthesia was induced by the administration of a simple dose of 0.5% bupivacaine in 8 ml to minimize effects on the cardiovascular system. During surgery, the patient received a low-dose titration of norepinephrine, complicated blood pressure, and cardiac output, and maintained a euvolemic state. As suggested by guidelines, this patient received post-operation care in the ICU with invasive hemodynamic monitoring, arterial line, and reevaluation of thoracic echocardiography, followed by administration of warfarin 12 hours post-operation. In the end, in this case, there were no events of thromboembolism, and continued monitoring with arterial line post-operation could provide actual and become a guide in maintaining stable hemodynamics.

4. Conclusion

In patients with MR, usually, there are several conditions followed along, such as congestive heart failure and hemodynamic instability. To understand MR pathophysiology and natural history, including patient symptoms, left ventricular function, and cardiac status. Decisions regarding anesthesia goals in these patients and anticipating potential intraoperative complications are important to ensure surgical success and reduce patient morbidity and mortality, and this is where hemodynamic monitoring and control play an important role postoperatively to prevent further deterioration and maintain stability.

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