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Continuous Spinal Anesthesia for Elderly Patient with Severe Restrictive Cardiomyopathy Undergoing Surgical Repair of the Hip

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Abstract

Diastolic dysfunction is being increasingly acknowledged as a sole cause of heart failure. Grade 3 diastolic dysfunction, also known as restrictive cardiomyopathy, is particularly noteworthy because its optimal therapy is distinct from that of most other grades of diastolic dysfunction and distinct from that of most systolic dysfunction. We present an 88 year old male with severe restrictive cardiomyopathy on home dopamine infusion, atrial fibrillation, and renal insufficiency, requiring left hip repair five days after a recent ICU admission for congestive heart failure. Continuous spinal anesthesia, spontaneous inhalational anesthetic ventilation via LMA, and titrated norepinephrine and epinephrine infusions avoided heart rate changes and volume administration. Spinal anesthesia was redosed before catheter removal, and the patient returned to the ICU extubated and comfortable. Patient was discharged to the floor the following day.

Introduction

The primary cardiovascular focus of perioperative providers has historically been systolic function and the factors (e.g. myocardial ischemia) that influence it. More recently, the role of diastolic dysfunction in perioperative morbidity and mortality has gained attention. Given the prevalence of diastolic dysfunction in people over 60 years old, the rising number of 60+ year old patients, and the unique care requirements of patients with severe diastolic dysfunction, a greater awareness of our patients' diastolic heart function is likely warranted [1]. As more patients with cardiomyopathy present for anesthesia and surgery, it is critical that anesthesiologists have a thorough understanding of its pathophysiology to properly manage and care for these patients. Restrictive cardiomyopathy is the most severe form of the three classic subtypes of cardiomyopathy. It is commonly caused by idiopathic fibrosis, but other less common causes include amyloidosis, sarcoidosis, and eosinophilic endocarditis [2]. The unique pathophysiologic feature of this condition is reduced ventricular compliance which prevents ventricular filling and predisposes to congestive heart failure [3].

Cardiac diastole is the cardiac phase during which the ventricle fills to accept the preload for cardiac systole. Diastole itself has two phases: 1) recoil – when muscle fibers cease contracting and instead spring back towards their resting length, sucking blood into the ventricle; and 2) stretching – when the muscle fibers are stretched beyond their resting length by blood forced into the ventricle due to atrial contraction. Recoil actually demands energy of the recoiling muscle fibers, a process that becomes less efficient with aging [4]. Though the body adapts to impaired recoil, these adaptive processes lead to reduced ventricular compliance and impaired myocyte stretching [5].

In diastolic dysfunction, ventricular filling is limited by either myocyte relaxation or by both myocyte relaxation and myocyte stretching. When recoil alone is impaired, a strategy of increasing atrial pressures (volume resuscitation) and slowing heart rate (to allow more time for ventricular filling) can often compensate. When myocyte stretching is also impaired (a.k.a. restrictive cardiomyopathy), these strategies fail because the noncompliant ventricle resists expansion [5]. Thus, volume resuscitation leads to pulmonary edema, and heart rate reduction decreases cardiac output by limiting the contraction frequency of a ventricle with fixed stroke volume. With restrictive diastolic dysfunction, it is imperative to "control damage" by maintaining sinus rhythm, allowing ventricular filling without administering excess fluid [6].

Hip fracture in the elderly is associated with a 30%-40% one year mortality [7], and perioperative

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morbidity and mortality further increase in those with multiple comorbidities [8]. Continuous spinal anesthesia is an attractive choice for patients with multiple cardiac comorbidities due to the improved hemodynamic control it provides. We report our anesthetic management with continuous spinal anesthesia of a patient with severe restrictive cardiomyopathy undergoing surgical hip repair.

Case Presentation

An 88 year old male presented for an intramedullary rod insertion of a left femoral fracture. History included severe restrictive cardiomyopathy from in transthyretin cardiac amyloidosis, NSTEMI s/p CABG, sick sinus syndrome with ICD/pacemaker, paroxysmal atrial fibrillation and flutter, and stage 5 CKD. He had been discharged five days earlier following an eight day hospitalization, including three days in the ICU, for aggressive diuresis of congested heart failure. Echocardiography demonstrated preserved global right ventricular systolic function, reduced global left ventricular systolic function with ejection fraction of 45%-50%, and grade III diastolic dysfunction with E to A ratio of 2.1, E to e' ratio of 28.5, and deceleration time of 162 ms. Home medications included continuous dopamine infusion to maintain perfusion pressure. Anesthetically, defibrillator pads, awake arterial line, and L3-4 spinal catheter were placed. Patient's home dopamine infusion was transitioned to epinephrine and norepinephrine infusions. Patient was administered 4 mg 0.5% bupivacaine and 10 μg fentanyl intrathecally, achieving a T12-sacral sensory block. LMA was placed (propofol and remifentanil induction) for spontaneous ventilation of low dose desflurane. The patient maintained spontaneous tidal volumes of 6-8 ml/kg, normal sinus rhythm without EKG changes and hemodynamic stability throughout the operation. Intravenous fluids were restricted to 250 ml of crystalloid with blood loss estimated at 50 ml throughout the two hour case. Approximately 90 minutes after the initial intrathecal dose, additional 0.8 mg 0.5% bupivacaine and 2 μg fentanyl were administered intrathecally to assist with post-operative pain control before removing the spinal catheter. Patient was extubated and returned to the ICU pain-free and interactive. He was transferred to the floor the next day.

Discussion

Severe restrictive diastolic dysfunction offers little flexibility in fluid administration, heart rate, heart rhythm and peripheral tone. Such limitations make the administration of general anesthesia difficult, as incomplete blockade of pain receptors combined with varying degrees of surgical stimulation leads to surges of sympathetic stimulation and hemodynamic fluctuations [9]. Regional anesthesia can potentially completely block afferent pain receptors. This effectively prevents fluctuations in sympathetic tone which would otherwise result from surgical stimulation [10]. Exogenous vasoactive agents can then be used to achieve the desired level of cardiac stimulation and vascular tone without the risk of superimposed endogenous influences.

Neuraxial blockade with epidural anesthesia or single dose intrathecal agent are common approaches to achieve this goal. Neuraxial blockade can develop suddenly, with rapid hemodynamic changes leading to myocardial ischemia, cardiac arrest, and brain damage [11-13]. Furthermore, duration of blockade and duration of surgery can each be unpredictable, making it difficult to match analgesia delivery and need. Epidural anesthesia, which offers the capacity for better control over duration of analgesia, gives a less certain degree of analgesia. Continuous spinal anesthesia, first described by Edward Tuohy in 1944, provides a more favorable profile of onset speed, block density, and hemodynamic stability than single dose spinal or continuous epidural anesthesia [8,14]. It allows individualized titration of intrathecal local anesthetic and opioids to control the level of the sensory and motor blockade according to surgical needs while maintaining hemodynamic stability required for patients with cardiomyopathy [15].

Based on whether recoil alone or both recoil and compliance are impaired, as well as on adaptations a patient's body has undertaken to compensate for impaired ventricular filling, 3 grades of diastolic dysfunction are described. In grade 1, recoil alone is compromised with no adaptations yet undertaken by the body. In grade 2, recoil alone is compromised, and the body has adapted by increasing atrial volume to help fill the ventricle. In grade 3 (restrictive cardiomyopathy), recoil and compliance are both compromised [16]. This evolves as a progression from grade 2, so the body has already maximized atrial volume. In grades 1 and 2, ventricular filling (and subsequent stroke volume) can be increased by volume resuscitation and heart rate control. In grade 3, ventricular filling is maximized already but can be compromised if venous return is decreased, intravascular volume is lost, atrial kick is lost and/or diastolic duration is shortened by tachycardia [17]. Overaggressive rate control can be problematic as well, compromising cardiac output by limiting contractions in the setting of fixed stroke volume [18].

Sympathectomy induced by spinal anesthesia can cause venous pooling and decreased end diastolic volume, ultimately decreasing cardiac output in a patient whose end diastolic volume is already compromised [19]. In anticipation of this, we converted our patient's home dopamine to epinephrine and added norepinephrine infusion to maintain peripheral tone. This allowed avoidance of significant volume administration as sympathectomy developed. Spontaneous ventilation of inhaled anesthetic through LMA was maintained to avoid patient restlessness given the sounds (e.g. drilling, physician discussion) and uncertain duration of surgery. Magnesium infusion was begun to maintain sinus rhythm, with cardioversion pads provided in case fluid shifts provoked atrial fibrillation. Intrathecal dosing was chosen to anticipate analgesic needs while minimizing hemodynamic fluctuations [20-22].

Conclusion

Restrictive cardiomyopathy requires specific treatment paradigms that are relatively unique even among the various cardiomyopathies. We present an anesthetic option for a patient with restrictive cardiomyopathy undergoing hip fracture repair. Continuous spinal anesthesia is an excellent option asit offers pain control, amnesia and loss of awareness while avoiding fluid shifts, significant heart rate variability and hemodynamic lability.

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