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CASE REPORT

Spinal Anesthesia in a Patient with reduced Ejection Fraction undergoing Below-Knee Amputation

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ABSTRACT

The ejection fraction is calculated by dividing the stroke volume by the end diastolic volume. It is literally the fraction of the end diastolic ventricular volume that is ejected with each beat. This measurement is important to know how well the heart is pumping out blood and decide in diagnosing heart failure (HF). Normally the percentage of EF is above 50%. A decrease in EF will make it difficult to perform anesthesia during surgery due to life-threatening arrhythmia, leading to sudden cardiac arrest and death. Patients with reduced ejection fraction need identification of risk factors, preoperative evaluation and optimization, correct medical therapy, adequate monitoring, and appropriate anesthetic technique and drugs. In this report, we present a 46-year-old man with reduced ejection fraction 30% and coronary artery disease who underwent below knee amputation surgery under spinal anesthesia. Spinal anesthesia was performed on the patient using low dose bupivacaine and fentanyl as adjuvant. Management of patients is aimed at maintaining adequate preload, avoiding tachycardia and arrhythmia along with maintaining afterload by maintaining a balance between oxygen supply and demand. Thus in patients with reduced ejection fraction, who are posted for noncardiac surgeries, the more preferable and safer alternative is regional anesthesia as it reduces the sympathetic stress response

Keywords: Ejection fraction, Spinal anaesthesia, Heart failure, Bupivacaine, Surgery

Background

Heart failure is a clinical syndrome in which the structural or functional dysfunction of the heart occurs in either systole or diastole or both. The most common cause is coronary insufficiency, in which the heart is not able to circulate blood rapidly between body tissues and collect it and, as result, patient experience shortness of breath, weakness, and fatigue.[i] The three major risk factors for the development of heart failure are age, hypertension and coronary artery disease. The people with coronary artery disease is increasing and anaesthesiologists are encountering more patient with history of coronary artery disease (CAD) undergoing non cardiac surgery. We have encountered patient with systolic heart failure secondary to CAD. This case report tries to highlight on pathophysiology of heart failure and appropriate anesthetic management of patient with heart failure undergoing non cardiac surgery.

Left ventricularEjection fraction (LVEF) is an important measurement in determining how well the heart is pumping out blood and in diagnosing as well as tracking the heart failure (HF).

LVEF is the fraction of chamber volume ejected in systole (stroke volume) in relation to the volume of the blood in the ventricle at the end of diastole (end-diastolic volume). Stroke volume is calculated as the difference between EDV and end-systolic volume (ESV). Congestive heart failure (CHF) is a major health burden, affecting 40 million people globally.[ii]

The European Society of Cardiology (ESC) 2016 classifies heart failure (HF) according to the assessment of the left ventricular ejection fraction (LVEF) measurement. The European Society of Cardiology (ESC) categorises heart failure (HF) into three distinct classes based on ejection fraction (EF). HF with reduced ejection fraction (HfrEF) which is defined as EF less than 40%, HF with midrange ejection fraction (HFmrEF) which is defined as EF between 40% and 49%, and HF with preserved ejection fraction (HfpEF) which is defined as EF equal to or greater than 50%. Heart failure with reduced ejection fraction is referred as systolic heart failure in which heart muscle does not contract effectively and less oxygen rich blood is pumped out of the body. Patients with a reduced ejection fraction (EF), specifically an EF below 35%, are at a heightened risk of life threatening complications owing to arrhythmias.[iii]

In diastolic heart failure, heart muscle contracts normally but the ventricles do not relax as they should during ventricular filling or when the ventricle relax[iv].
The goals of anesthetic management of the patient with low ejection fraction include avoiding drug-induced myocardial depression, preventing arrhythmias and maintaining adequate cardiac output.[v]

Normal ejection fraction varies from 50% to 75%. Patients with an EF < 35% (very low EF) may be at risk for life-threatening irregular heartbeats (arrhythmias) leading sudden cardiac arrest become sudden death[vi]. Any arrhythmia in these patients needs prompt treatment.

Anaesthesiologists are required to provide good quality and safe care in operating room for patient with low ejection fraction.

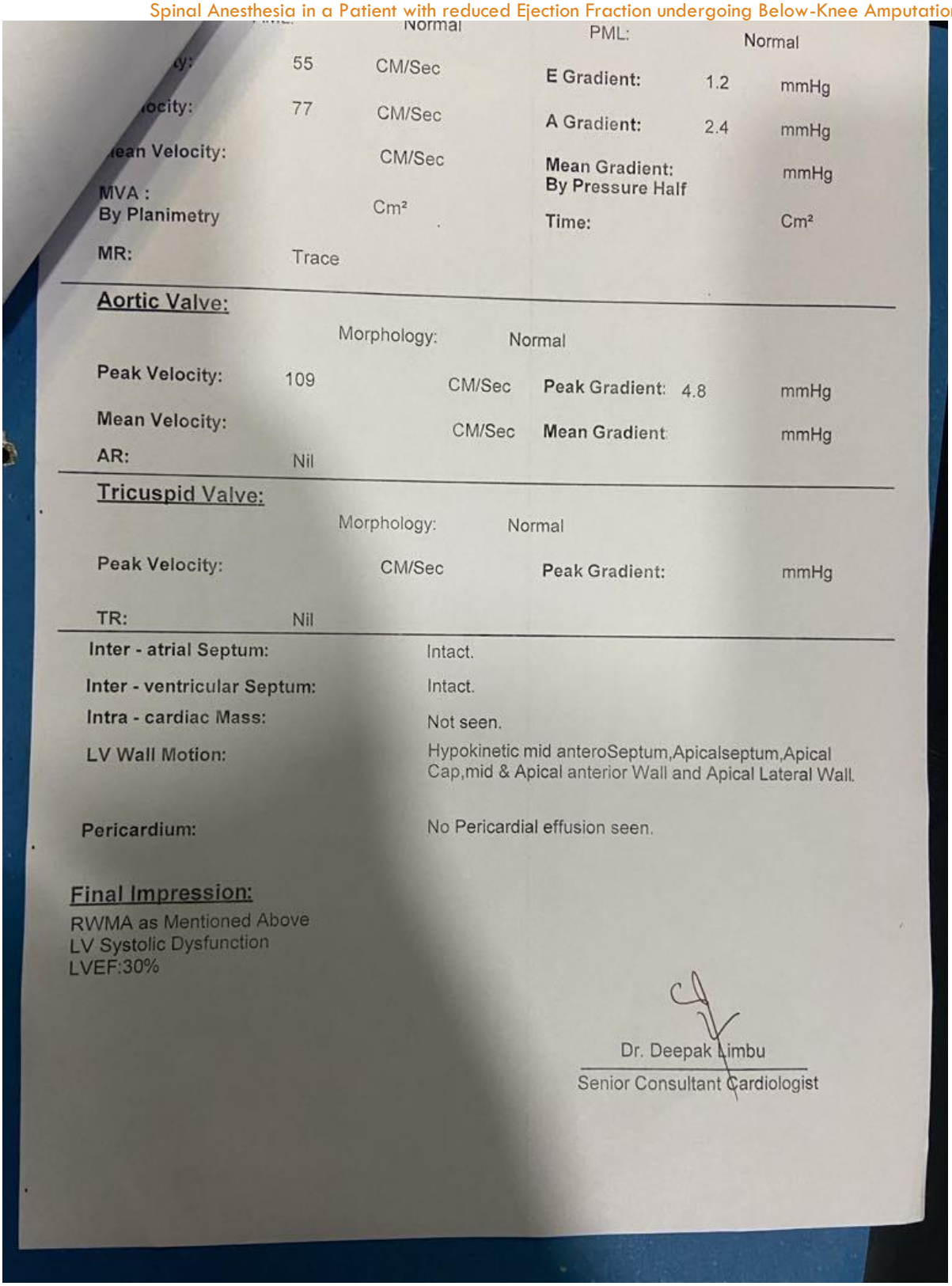
Patient with low ejection fraction required early identification of risk factor,preoperative evaluation and optimization, correct medical therapy, adequate monitoring and appropriate anaesthetic technique and drugs. During induction of anaesthesia and intubation which is noxious stimuli, can trigger unwanted responses in the cardiovascular, respiratory and other physiological system. Tachycardia, hypertension and arrhythmia during this stimuli can be detrimental to patient with poor cardiovascular reserve.

Case report

A 46-year-old man (80 kg, 177 cm) was scheduled for below-knee amputation after he was found to have left lower limb foot ulcer associated with whole foot gangrene and osteomyelitis. He has history of hypertension, COPD and pulmonary tuberculosis. He has history of type 2 diabetes mellitus and coronary artery disease with anterior wall ST elevation MI. Echo shows regional wall motion abnormality in LAD territory with ejection fraction of 30 percent. Bilateral lower limb arterial duplex ultrasonography was suggestive of peripheral arterial disease with atherosclerotic changes. Other organ function and biochemical disturbances included mild hypokalemia, hypernatremia, hyperglycemia, and leukocytosis. His medications included glargine insulin, metformin, aspirin, atorvastatin, losartan and metoprolol.

After informed consent, he was taken to the operating room where standard monitors were placed, and supplemental oxygen was administered via nasal cannula. A urinary catheter was placed to monitor urine output. Central venous catheter was inserted into right internal jugular vein with the aid of ultrasonograhy. Arterial catheter was inserted into right radial artery for invasive blood pressure monitoring.

The patient was then placed in a sitting position for spinal anesthetic administration.The spinal block was performed by a consultant anesthetist between the level of L3 and L4 inter- space using the midline approach. The skin was anesthetized with 3 mL of lidocaine 2%, and a 26-G Quincke spinal needle was used to administer a mixture of heavy bupivacaine 10 mg in 2 mL , and fentanyl 20 µg in 0.4mL volume. . Immediately after the intrathecal injection, the patient was placed with the operative side down and the head 15 up. The sensory assessment revealed a loss of pinprick sen sation to the level of T10 dermatomes and extending to both posteriorly and anteriorly.



Normal PML: Normal

55 CM/Sec E Gradient: 1.2 mmHg

77 CM/Sec A Gradient: 2.4 mmHg

Mean Velocity: CM/Sec Mean Gradient: mmHg

MVA : By Planimetry Cm² By Pressure Half Time: Cm²

MR: Trace

Aortic Valve:

Morphology: Normal

Peak Velocity: 109 CM/Sec Peak Gradient: 4.8 mmHg

Mean Velocity: CM/Sec Mean Gradient: mmHg

AR: Nil

Tricuspid Valve:

Morphology: Normal

Peak Velocity: CM/Sec Peak Gradient: mmHg

TR: Nil

Inter - atrial Septum: Intact.

Inter - ventricular Septum: Intact.

Intra - cardiac Mass: Not seen.

LV Wall Motion: Hypokinetic mid anteroSeptum,Apicalseptum,Apical Cap,mid & Apical anterior Wall and Apical Lateral Wall.

Pericardium: No Pericardial effusion seen.

Final Impression:

RWMA as Mentioned Above
LV Systolic Dysfunction
LVEF:30%

Dr. Deepak Limbu
Senior Consultant Cardiologist

Heart rate, oxygen saturation, and blood pressure were recorded before spinal anesthesia (baseline: mean blood pressure, MAP 90 mmHg; heart rate, HR 72 bpm; and S O2 at room air, 90%), just after spinal anesthesia till the end of surgery.Because of invasive blood pressure monitoring, Blood pressure could be monitored on every heart beat. Invasive blood pressure was used because of low ejection fraction. Hemodynamic stability was maintained throughout surgery (ie, MAP, 75–90 mmHg; HR, 80–100 bpm; and average hourly urine output, 0.5 mL/kg around 30 ml) using intravenous phenylephrine and mephentermine. His SpO2 and skin temperature were maintained between 95% and 99%, and 36.0–36.8 °C, respectively. The rapid blood sugar test result at admission to operation theatre was 205 mg/dL.

Intravenous regular insulin infusion (1unit/hour) was administered over and the serum glycemic level was kept below 180 mg/dL. The surgical procedure lasted 90 minutes without any apparent complications. He received a total of 1050 mL crystalloid and one unit packed red blood cells (PRBCs). The total estimated blood loss (EBL) was 400 mL, and the urine output was 150 mL.

The patient was transferred to the postanesthesia care unit for further monitoring and then transported to the medical ward. He did not experience any nausea, vomiting, pruritus, hypotension, or postdural puncture headache during his postoperative course.

Discussion

Ejection fraction is an important measurement in determining function of the heart. Normal ejection fraction varies from 50% to 75%. Patients with an EF < 35% (very low EF) may be at risk for life-threatening irregular heartbeats (arrhythmias) leading sudden cardiac arrest become sudden death.

PATHOPHYSIOLOGY

Characteristically the chambers of the heart become enlarged, with increased wall thickness and stiffness. Underlying this is a process of fibrosis and myocellular hypertrophy. These morphological changes lead to important functional changes which affect both diastole (relaxation) and systole (contraction).

Preoperatively adequate history regarding the severity, progression and functional limitations needs to be taken properly, such as decreased exercise intolerance (indicating the cardiac reserve), angina (indicating myocardial ischemia), and other noncardiac chronic comorbidities such as systemic hypertension, cardiovascular accidents, and diabetes mellitus. The examination includes general and system-specific examinations. In systemic, the cardiovascular system needs to be examined for the presence of any murmur or abnormal heart sounds. The respiratory system is also to be examined.

Cardiac-specific tests, like ECG and echocardiography, were done to know about the ejection fraction, valvular lesion, any regional wall motion abnormalities, pressure gradients, and LV function. Other investigations are complete blood count (CBC), serum electrolytes, fasting blood sugar (FBS), and chest X-ray. In our case report we did echocardiography preoperatively to see the valvular abnormalities which was not present.

The decrease in ejection fraction in this patient was caused by myocardial infarction which caused impaired myocardial contractility. The use of antiplatelets in the medication of patients with myocardial infarction requires special attention, especially in patients with a high risk of bleeding such as trauma or surgery. Patient was only taking aspirin. He has history of taking clopidrogel which was stopped after continuing for 2 years.

Medical strategy for patients with low EF includes use of beta adrenergic antagonists, diuretics, and salt restriction to decrease fluid retention and angiotensin converting enzyme inhibition or angiotensin II receptor blockers to decrease cardiac remodeling.[vii]In our case, beta adrenergic antagonist, angiotensin II receptor blocker were used for medical management.

Treatment of diuretics, β blockers, and ARBs in these patients was continued during the peri, intra, and postoperative periods. Discontinuation of β blockers, ARBs, calcium channel blockers, nitrates, statins, or ACE inhibitors in the perioperative period can increase perioperative morbidity and mortality and should be avoided.[viii]

Intraoperatively, preload and adequate contractility of the heart is maintained. Occurrence of regional anesthesia-induced hypotension is monitored carefully and if it occurs, it is managed appropriately with vasopressors or by inotropic supports. Intraoperative cardiac events such as arrhythmias need to be monitored. An adequate level of motor and sensory blockade must be attained to perform the surgery, higher levels of subarachnoid blockade need to be avoided

The goals of anesthetic strategy of the patient with a low ejection fraction include maintaining cardiac output, preventing arrhythmias and avoiding myocardial depression by avoiding factors that upset the balance of oxygen supply and demand. We should be careful in maintaining appropriate preload and preventing increase in afterload. Oxygen balance in the myocardium is achieved by neither reducing supply nor increasing demand. Decreased supply is obvious due to hypotension, and increased demand due to tachycardia or hypertension.

In this case we used low dose bupivacaine with fentanyl as adjuvant so that there is less chance of hypotension after giving spinal anaesthesia and adequate nerve block for surgery without any further complication. Vasodilation associated with regional block may lead to a critical reduction of cardiac output and peripheral vascular resistance. Hypotension decrease oxygen supply to myocardium which is detrimental in patient with reduced ejection fraction. We used drug such as phenylephrine and mephentermine to increase blood pressure in episode of hypotension. Optimal Fluid management was addressed to maintain appropriate preload.

Spinal anaesthesia is another alternative for successful management of patients with low ejection fraction using a low dose of bupivacaine with intrathecal adjuvants. One of the case study done by Mitiku Desalegn indicates that caesarean section also may be managed safely with spinal anaesthesia alone in patients with DCM, by using low-dose bupivacaine and intrathecal morphine.[ix]

In similar study done by Divya et al, Transurethral resection of prostrate and bilateral hernioplasty was done using combined epidural and spinal anaesthesia. This case has ejection fraction of 30% and spinal anaesthesia was carried out with 1.2 ml of 0.5% bupivacaine and 25 mcg of fentanyl.[x]

Spinal anaesthesia with low-dose bupivacaine with opioids is another suitable choice.

The patient should be continuously monitored for any postoperative cardiac events and adequate fluid and pain management should be done.

Conclusion

In conclusion, patients with low EF are considered to be at high risk for anaesthesia due to life threatening arrhythmias leading to sudden cardiac arrest and death. The goals of perioperative management in these patients include maintaining cardiac output, adequate heart rate and avoidance of cardiac depressant. Spinal anaesthesia with low dose dose bupivacaine and adjuvants such as fentanyl is suitable choice for the patient which can be done in regional anaesthesia.

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