Elective use of intra-aortic balloon pumping during Whipple's procedure in a patient with ischaemic heart disease

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Abstract

A 61-year-old man with diabetes who presented with carcinoma of the head of the pancreas was detected to have severe coronary artery disease. Coronary artery bypass grafting was advised. In view of the urgent nature of the abdominal surgery, resection of the malignancy was carried out prior to coronary revascularisation, after placement of an intra-aortic balloon pump (IABP) following induction of anaesthesia to prevent perioperative myocardial ischaemia. The use of an IABP in a noncardiac setting is not well established. Only 16 cases have been reported. To the best of our knowledge, this is the second documented case of the use of elective IABP during Whipple's procedure.

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Introduction

Intra-aortic balloon pumping (IABP) has been documented to improve mean arterial blood pressure, increase myocardial perfusion, reduce afterload and decrease myocardial oxygen demand by reducing cardiac work.[1] In contrast to cardiac surgery, the indications for its use during noncardiac surgery are not well defined. There have been sporadic reports on its use in increasing the safety of noncardiac surgery in high-risk patients with ischaemic heart disease.

Case study

A 61-year-old man with diabetes, who presented with obstructive jaundice, underwent a computerised tomography scan of the abdomen, which revealed a 31 x 30 x 29 mm tumour that was predominantly positioned in the uncinate process of the pancreas and causing dilatation of the biliary and pancreatic ducts. He also complained of angina (Class II according to the New York Heart Association classification). His electrocardiogram showed sinus rhythm and q waves in leads V1 to V3. An echocardiogram demonstrated diastolic dysfunction, a mild reduction in left ventricular function (ejection fraction = 50%) and hypokinetic mid-distal interventricular septum and apex.

A coronary angiogram was performed (Figure 1). The left main coronary artery showed a distal block of 60-70%. The left anterior descending artery was a type-3 vessel with 75% ostial block and diffuse disease of mid-segment. Ramus intermedius showed 75% ostial block. The first diagonal artery had diffuse disease. The left circumflex artery demonstrated 50% ostial block and 95% block in the distal segment. The right coronary artery revealed 75% ostial and 50% block in the mid segment. In light of the triple vessel involvement and the left main trifurcation lesion, coronary artery bypass grafting (CABG) wa s favoured over angioplasty as the appropriate intervention. Angioplasty and stenting of this lesion would certainly result in one or more of these vessels shutting down after the procedure. Moreover, the risk of bleeding during subsequent surgery is increased during the peri-stenting period because of clopidogrel use.

The sequence of the surgical procedures was a matter of debate and it was decided to proceed with the malignancy resection as it was the priority at the time and a time delay after cardiac surgery would have adversely affected the patient's long-term outcome. Another factor was his high bilirubin and international normalised ratio (INR) levels, which could have led to potentially life-threatening bleeding during CABG. The relief of obstructive jaundice prior to CABG was also favoured to correct bleeding parameters.

An elective IABP (Maquet® Cardiac Assist CS-300) was used (Maquet, Rastatt, Germany) during the Whipple's procedure to reduce the risk of a perioperative myocardial infarction as this would have reduced the left ventricular

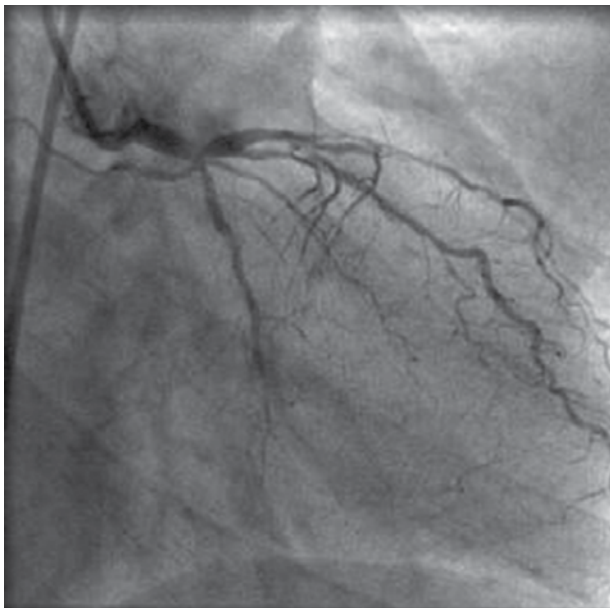

Figure 1: Coronary angiogram right anterior oblique view showing left main coronary artery with a severe trifurcation stenosis at the junction of left anterior descending, circumflex and ramus intermedius

workload and augmented myocardial perfusion. During the consent process, the patient was informed of his increased risk of cardiovascular events and perioperative death and the need for IABP support.

Beta blockers, aspirin and statins were continued until the day of surgery. The patient was premedicated with injected ranitidine 50 mg and injected ondansetron 4 mg intravenously, given 30 minutes before induction. Induction was carried out with 100 µg fentanyl, 1 mg midazolam and 16 mg etomidate. Muscle relaxation was achieved with 6 mg vecuronium. Anaesthesia was maintained with oxygen and air, 6-8% desflurane, fentanyl and vecuronium. Invasive monitoring was performed using a left radial arterial line and a Swan-Ganz® catheter (Edwards, Irvine, California, USA). The IABP was inserted via the left femoral artery after the induction of anaesthesia, without heparin cover. The patient was not heparinised, considering his elevated INR and the risk of increased bleeding during surgery. IABP showed good augmentation and ran on a 1:1 ratio throughout the procedure. An uncomplicated Whipple's resection (pylorus-preserving pancreaticoduodenectomy) with feeding jejunostomy was performed through a Cheveron incision. Intraoperatively, the patient's vitals were monitored, the heart rate was maintained between 70-90 beats per minute, the mean arterial blood pressure was sustained above 80 mmHg and the augmented diastolic pressure was retained above 110 mmHg. The surgery took four hours, during which time total urine output was 430 ml and approximate blood loss was 550 ml. After an uneventful intraoperative course, the patient was extubated on the table and shifted to the surgical intensive care unit for further monitoring.

The IABP was removed four hours later, in view of the stable intraoperative condition with no complications. Serial electrocardiograms and cardiac enzymes were normal postoperatively. The patient was discharged from the intensive care unit 48 hours after the surgery and from the hospital on the twelfth postoperative day with no complications. At three weeks, he was doing well and awaiting elective CABG.

Discussion

Patients with critical coronary artery disease are at higher risk of perioperative myocardial infarction and mortality during noncardiac surgery. Left main disease with triple-vessel disease is an indication for CABG.[2] In such cases, CABG, followed by an interval of several weeks to three months, is recommended before elective noncardiac surgery.[3,4] However, since this patient had a malignancy, a delay of several weeks was not acceptable. It was prudent to proceed with malignancy surgery after optimising perioperative management.[3] Compared to optimal pharmacological management, such as beta blockade, the use of IABP as a perioperative tool in a similar clinical scenario has not been well established.[5,6]

IABP functions by increasing myocardial perfusion, reducing afterload, decreasing myocardial oxygen demand and improving mean arterial blood pressure. During diastole, the balloon inflates, displacing blood from the descending aorta and then deflates immediately before systole, creating a void in the aorta. Coronary perfusion occurs mainly during diastole. Diastolic inflation of the IABP causes a rise in the aortic diastolic pressure, with an increase in the coronary perfusion pressure (CPP) [CPP = diastolic blood pressure (DBP) - left ventricular end diastolic pressure (LVEDP)], the pressure gradient and coronary flow. Presystolic deflation of the balloon reduces the pressure in the aorta during left ventricular systole, reducing the afterload and isovolumetric contraction phase of systole, which in turn translates into a lower oxygen demand (Figure 2). This makes it an attractive tool with which to prevent myocardial ischaemia in any clinical scenario. The effects of IABP are summarised in Table 1.

Figure 2 illustrates diastolic blood pressure augmentation, which improves coronary blood flow during diastole as a result of a raised coronary perfusion pressure (coronary perfusion pressure = diastolic blood pressure – left ventricular end diastolic pressure). The presystolic dip in aortic pressure reduces the afterload during left ventricular systole, leading to decreased stroke work and myocardial

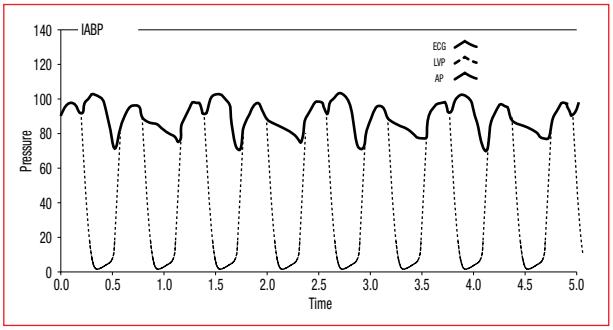

Figure 2: Aortic and left ventricular pressure curves during a 1:2 intra-aortic balloon pumping assist

Table I: The haemodynamic effects of intra-aortic balloon pumping

Aorta	A decrease in systolic pressure, an increase in diastolic pressure and an increase in mean pressure
Left ventricle	A decrease in systolic pressure and the isovolumetric contraction phase, a decrease in end-diastolic pressure, a decrease in volume, adecrease in wall tension and an increase in ejection fraction
Heart	A decrease in afterload, a decrease in preload, an increase in cardiac output and a decrease in oxygen consumption
Blood flow	An increase in coronary blood flow and an increase in peripheral perfusion

oxygen consumption. The reduction in left ventricular afterload also leads to better left ventricular systolic function, giving rise to decreased left ventricular end diastolic volume and left ventricular end diastolic pressure.

Use of the IABP has its own risks. The rate of incidence of major complications of 2.6%, including severe bleeding, major limb ischaemia, balloon leak and mortality, has been directly attributable to the IABP.[7] It can also lead to thrombocytopaenia. We did not consider heparinisation during IABP use in this patient because of his elevated INR levels and the risk of bleeding. Cooper et al[8] have demonstrated that during IABP usage, a selective heparinisation strategy is justified rather than universal heparinisation. However, we encountered a problem during this case: bleeding was slightly more than usual and haemostasis was difficult. The reasons for this could have been the elevated INR levels and increased pulsations during IABP usage, which could have prevented vasospasm of the bleeding vessels.

The most common use of the IABP is during or after high-risk cardiac catheterisation or cardiac surgery.[7] Elective use of the IABP in high-risk ischaemic heart disease patients prior to high-risk CABG surgery has been shown to reduce hospital deaths and to lower the incidence of low cardiac output.[9] With the success of elective IABP prior to elective cardiac surgery, case reports and small case series have described its use in noncardiac surgery which carries high cardiac risk.[10-14] Either malignancy or emergency operations were performed. In one study, there were no myocardial events while the IABP was in situ. Two of the 16 patients suffered a cardiac event prior to hospital discharge. However, there were no further in-hospital deaths and no other complications with regard to the IABP.

Conclusion

We believe that this is the second described case of a Whipple's procedure that was performed successfully using IABP support in a patient with high cardiac risk. The few reported cases of its use prior to noncardiac surgery in high-risk cardiac patients have demonstrated a favourable outcome. In some clinical situations, it may not be appropriate to delay surgery for a progressive disease such as a malignant tumour, or emergency surgery to allow time for coronary artery bypass surgery. Some lesions that are operable at the time that they are diagnosed may become inoperable if surgery is not performed promptly. Particularly in cases with obstructive jaundice, the deranged coagulation parameters may normalise after correction of the obstruction by the Whipple's procedure. This reduces the risk of bleeding during a CABG operation, making it safe at a later date. In such situations, there have been no randomised control trials on the risks and benefits of using IABP compared to optimal medical management for perioperative support. From the available data, the use of IABP looks promising as a perioperative adjunct to optimal pharmacological management in emergency and urgent noncardiac operations in patients with high-risk coronary disease. We believe that further evidence from randomised trials is needed before recommending its routine clinical use in such clinical scenarios.

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