ACS Case Reviews in Surgery
Vol. 3, No. 7

Utility of Intra-Aortic Balloon Pumps in Surgical Oncology

AUTHORS:
Quinn PL[a]; Prasath V[b]; Shaikh I[b]; Linton AA[b]; Eloy JD[c]; Chokshi RJ[b]

CORRESPONDING AUTHOR:
Patrick L. Quinn, MD
The Ohio State University College of Medicine
395 W. 12th Avenue
Columbus, OH 43210
Phone: (614)-293-8701
Email: patricklquinn12@gmail.com

AUTHOR AFFILIATION:
a. Department of Surgery
The Ohio State University College of Medicine
Columbus, OH 43210

b. Division of Surgical Oncology
Department of Surgery
Rutgers New Jersey Medical School,
Newark, NJ 07103

c. Department of Anesthesiology
Rutgers New Jersey Medical School
Newark, NJ 07103

Background	Four patients diagnosed with cancer in the setting of severe cardiac disease underwent oncologic operations with the support of a perioperative intra-aortic balloon pump after being deemed unsuitable for revascularization.
Summary	Patients with cardiovascular disease are at increased risk of adverse cardiac events during surgery. One method of minimizing these risks is using an intra-aortic balloon pump (IABP). While its use in cardiac procedures is well established, there is limited data regarding the use of IABPs in noncardiac surgery. Small case studies report the successful use of IABPs in various noncardiac surgeries. We aimed to supplement this evidence by reporting our institution's experience with IABP use in surgical oncology. At our institution, four patients diagnosed with cancer in the presence of severe cardiac disease had abdominal or pelvic surgery performed. In each case, an IABP was placed preoperatively without complication and was removed within 48 hours. There were no intraoperative complications; however, three patients endured postoperative complications. Three of the four patients were discharged home safely, and two patients are doing well three years postoperatively.
Conclusion	We present four cases where an IABP was used safely during oncologic operations. This case series highlights a rarely used remedy that may be particularly useful for patients with cancer who would otherwise not be considered candidates for curative resection due to a high risk of perioperative complications.
Key Words	intra-aortic balloon pump; counterpulsation; surgical oncology

DISCLOSURE:
The authors have no conflicts of interest to disclose.

FUNDING/SUPPORT:
The authors have no relevant financial relationships or in-kind support to disclose.

RECEIVED: August 27, 2020
REVISION RECEIVED: November 19, 2020
ACCEPTED FOR PUBLICATION: December 7, 2020

To Cite: Quinn PL; Prasath V; Shaikh I; Linton AA; Eloy JD; Chokshi RJ. Utility of Intra-Aortic Balloon Pumps in Surgical Oncology. *ACS Case Reviews in Surgery.* 2022;3(7):7–11.

Case Description

Our case series consists of four patients with coexisting malignancy and severe cardiac disease who underwent noncardiac surgery at our institution between January 2014 and January 2018 with the aid of a perioperative intra-aortic balloon pump (IABP) (Table 1). All four patients were males over 55 years of age. Three patients were diagnosed with colorectal adenocarcinomas, and the other patient presented with a pancreatic neuroendocrine tumor (Table 2). In addition to their malignancies, each patient had accompanying comorbidities, with diabetes and hypertension being the most common. Due to the differences in tumor location, each of the colorectal cancer patients underwent a different procedure: total pelvic exenteration, right hemicolectomy, and lower anterior resection. The patient with the neuroendocrine tumor did not undergo resection but underwent an exploratory laparotomy with an open-core needle biopsy. None of the patients underwent neoadjuvant therapy prior to surgery.

All patients had significant cardiac disease (Table 1); however, none had a history of arrhythmia, including atrial fibrillation. Each was considered a high-risk candidate for surgery as defined by a Lee Revised Cardiac Index Risk of four and an American Society of Anesthesiologists Classification (ASA) of four. A Lee Index of four indicates an 11% risk of major cardiac complications during surgery. An ASA of four indicates the patient has a severe systemic disease that is a constant threat to life. For each patient, it was determined that the benefit of surgery outweighed the cardiac risk. For patient 1, clinical deterioration secondary to sepsis caused by a rectovesical fistula led to emergent surgery. In the second case, the cardiology team deemed that revascularization would be of little benefit due to the severity of cardiac disease, as a perfusion study revealed a severe perfusion defect in the entire apex. For the third case, the treatment team, in concurrence with the patient's wishes, decided that they did not want to delay a definitive diagnosis of the mesenteric mass by undergoing revascularization first. Lastly, patient 4 was experiencing cardiac ischemia due to the anemia caused by his colorectal cancer, leading to an urgent operation. Before proceeding to surgery, the treatment team explained the risks associated with undergoing major surgery, emphasizing the possibility of death.

In each of our cases, the primary rationale for the use of an IABP during surgery was due to severe coronary artery disease (CAD) (Table 1). Due to these cardiac risks, it was determined that each patient would benefit from IABP assistance during surgery. At our institution, IABPs have previously been used as a cardiac optimization tool for noncardiac surgery, such as in orthopedics. However, IABPs had not previously been implemented in surgical oncology cases at our institution. Typically, these patients would not have been considered surgical candidates and would have been offered medical therapy instead.

Table 1. Patient Medical History

	Patient 1	Patient 2	Patient 3	Patient 4
Age	66	81	57	63
Gender	Male	Male	Male	Male
Medical History	Diabetes Nephrostomy Tube	Hypertension	Diabetes Hypertension CKD Stage III	Diabetes Hypertension Alcoholic Cirrhosis
BMI	26.1	29.3	32.2	28.4
Smoker	No	No	Yes	Yes
EF	35%	15%	55%	50%
CAD	Prox. LAD: 50-70% Dist. LAD: 90% RCA: 100% OM1: 100%	LAD: 100% LCx: 40-50% RCA: 100% OM1: 100%	LAD: 50% LCx: 60% RCA: 100% OM1: 100%	L Main: 30-40% LAD: 80-95% LCx: 70% RCA: 40%

BMI = Body Mass Index; CAD = Coronary Artery Disease; CKD = Chronic Kidney Disease; Dist. LAD = Distal Left Anterior Descending Artery; EF = Ejection Fraction; IABP = Intra-Aortic Balloon Pump; LCx = Left Circumflex Artery; L Main = Left Main Coronary Artery; OM1 = First Obtuse Marginal Artery; MI = Myocardial Infarction; Prox. LAD = Proximal Left Anterior Descending Artery; RCA = Right Coronary Artery

Table 2. Patient Malignancy and Operation

	Patient 1	Patient 2	Patient 3	Patient 4
Tumor	Colorectal Adenocarcinoma	Colorectal Adenocarcinoma	Neuroendocrine Tumor	Colorectal Adenocarcinoma
Preoperative Staging	Para-aortic and bilateral inguinal lymphadenopathy identified on CT	No evidence of metastatic disease on CT scan	Mesenteric soft tissue mass and lymphadenopathy in mid abdomen concerning for metastases	No evidence of metastatic disease on CT scan
Stage	T4bN1b	T3N0	-	T1N0
Grade	Low-Grade	Low-Grade	Low-Grade	Low-Grade
Surgery	Total Pelvic Exenteration with Double-Barreled Wet Colostomy	Right Hemicolectomy	Core Needle Biopsy of Retroperitoneal Mass	Lower Anterior Resection with End Colostomy
Adjuvant Therapy	Scheduled for Chemoradiation	Not a Candidate	Octreotide	Not Indicated

Table 3. Patient Outcomes

	Patient 1	Patient 2	Patient 3	Patient 4
IABP-Associated Complications	None	None	None	None
Intraoperative Complications	None	None	None	None
IABP Removal Day	Postoperative Day 1	Postoperative Day 0	Postoperative Day 0	Postoperative Day 2
Vasopressor Use Postoperatively	Yes	No	No	Yes
Postoperative Complications	Sepsis	None	Ischemic Event	Anemia UTI
Postoperative Stay (Days)	30	13	6	22
Mortality	Expired at 30 Days Postop	Alive at 3 Years Postop	Expired 3 Years Postop	Alive at 3 Years Postop

IABP = Intra-aortic balloon pump; UTI = Urinary tract infection

Patient outcomes are displayed in Table 3. In each of the four cases, the IABP was placed preoperatively on the day of surgery without complication by a cardiologist within our institution's catheterization laboratory. A perfusionist was not employed in any of the cases to monitor the IABP during surgery, nor was transesophageal echocardiography used. A cardiac anesthesiologist was employed only for patient 1's case; transplant anesthesiologists performed the other cases. In each case, the IABP was removed within 48 hours postoperatively after demonstrating hemodynamic

stability and no cardiac ischemia, as evidenced by serial troponins. Both patient 1 and patient 4 required vasopressors before IABP removal, with patient 1 requiring vasopressors post-removal due to ongoing sepsis.

No complications were associated with the IABP, and there were no intraoperative complications. Three of the four patients endured postoperative complications, with one patient succumbing to complications from sepsis at 30 days. Only one patient had a cardiac-related complication of ischemia, which was evidenced by an asymptomatic rise in troponins following surgery. The three other patients were discharged home safely, with the length of stay ranging from 6 to 22 days. One patient expired three years after surgery due to his cardiac disease, whereas the other two are doing well three years postoperatively.

Discussion

Patients with cardiac disease are at high risk for perioperative cardiac complications, including myocardial infarction, cardiac arrest, and arrhythmias. Despite these risks, proper preoperative assessment and medical management can help mitigate adverse events during the perioperative period. One device that has shown benefit in this regard, while being safe and cost-effective, is the IABP.[1] However, this has been primarily seen and studied within cardiac procedures such as percutaneous coronary intervention (PCI) or coronary artery bypass grafts (CABG).

Currently, the American College of Cardiology and the American Heart Association supports using IABPs in patients with cardiogenic shock, mechanical complications following acute myocardial infarction (MI), refractory ventricular arrhythmias, and high-risk patients undergoing PCI and CABG.[2] Limited data exists within the published literature regarding the use of IABPs in noncardiac surgeries. These studies report the effective use of IABPs across various abdominal procedures, with cholecystectomy being one of the more commonly reported abdominal procedures.[3–6] Therefore, the goal of our report was to further supplement the evidence where IABPs were used successfully so their potential could be further elucidated, specifically during oncologic operations.

In our study, we presented four cases from our institution. Each of these patients was diagnosed with cancer and significant cardiac disease, alongside several other comorbidities, further complicating their management. These patients were deemed unsuitable for revascularization before surgery. IABP insertion was determined to help minimize cardiac risks during each patient's operation. When considering the patient's medical histories and the morbidity associated with the surgeries they underwent, we found the use of IABPs to be successful. This cohort exhibited no IABP-related or intraoperative complications, and none of the patients had life-threatening cardiac complications despite each having severe CAD. One patient expired from sepsis-related complications 30 days post-procedure. As a point of reference, a 2.6% major IABP complication rate (e.g., limb ischemia, severe bleeding, etc.) and a 21.2% in-hospital mortality rate was reported in a large registry study examining the use of IABP within current indications (e.g., cardiac catheterization, cardiogenic shock, etc.).[7]

In addition to the potential value in noncardiac surgeries, we want to highlight the beneficial role IABPs may have specifically for cancer patients. Those with malignancy and severe CVD may not be considered candidates for curative resection due to their high risk of perioperative complications. Instead, they would likely be subject to potentially less-effective treatments such as chemotherapy and radiation, both of which have risks of cardiovascular complications. As a specific illustration, we presented the case of a patient who succumbed to his cardiac disease three years following tumor resection. The patient underwent curative resection of his colorectal malignancy due to the hemodynamic support provided by the IABP. Considering the low complication and operative mortality rate seen within our study and others of similar focus,[3–6] we find a consensus that the use of a prophylactic IABP may be particularly beneficial to select cancer patients with significant cardiac disease.

Because the amount of data available limits our study, we encourage the continued reporting of instances where IABPs are used for noncardiac procedures. Additional literature is crucial to gaining a well-nuanced understanding of scenarios in which IABP may or may not be helpful, safe, and cost-effective. Beyond this, further exploration of the utility of IABPs should occur in more formalized studies, with larger cohorts assessed from a prospective analysis.

Conclusion

We present four cases where an IABP was used perioperatively during oncologic operations. In the absence of intraoperative or severe cardiac complications, our results further supplement the findings within the literature that

support the use of IABPs in noncardiac surgeries. Furthermore, IABPs may have added benefits for those with resectable cancers in the presence of severe cardiac disease, as these patients can potentially undergo curative resection.

Lessons Learned

Cancer patients with severe cardiac disease who are unsuitable for revascularization can safely undergo oncologic operations with the aid of an IABP. In select patients not suitable for revascularization, the use of the IABP should be considered to improve the outcomes and safety of noncardiac surgeries.

References

1. Dietl CA, Berkheimer MD, Woods EL, Gilbert CL, Pharr WF, Benoit CH. Efficacy and cost-effectiveness of preoperative IABP in patients with ejection fraction of 0.25 or less. *Ann Thorac Surg*. 1996;62(2):401-409.
2. Ihdayhid AR, Chopra S, Rankin J. Intra-aortic balloon pump: indications, efficacy, guidelines and future directions. *Curr Opin Cardiol*. 2014;29(4):285-292. doi:10.1097/HCO.0000000000000075
3. Georgen RF, Dietrick JA, Pifarre R, Scanlon PJ, Prinz RA. Placement of intra-aortic balloon pump allows definitive biliary surgery in patients with severe cardiac disease. *Surgery*. 1989;106(4):808-814.
4. Shayani V, Watson WC, Mansour MA, Thomas N, Pickleman J. Intra-aortic balloon counterpulsation in patients with severe cardiac dysfunction undergoing abdominal operations. *Arch Surg*. 1998;133(6):632-636. doi:10.1001/archsurg.133.6.632
5. Siu SC, Kowalchuk GJ, Welty FK, Benotti PN, Lewis SM. Intra-aortic balloon counterpulsation support in the high-risk cardiac patient undergoing urgent noncardiac surgery. *Chest*. 1991;99(6):1342-1345. doi:10.1378/chest.99.6.1342
6. Burgio G, Martucci G, Panarello G, et al. Intra-Aortic Balloon Counterpulsation in High-Risk Cardiac Patients Undergoing Noncardiac Surgery: A Case Series. *J Cardiothorac Vasc Anesth*. 2016;30(2):428-431. doi:10.1053/j.jvca.2015.06.010
7. Ferguson JJ 3rd, Cohen M, Freedman RJ Jr, et al. The current practice of intra-aortic balloon counterpulsation: results from the Benchmark Registry. *J Am Coll Cardiol*. 2001;38(5):1456-1462. doi:10.1016/s0735-1097(01)01553-4