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Management of Patients with Refractory Cardiogenic Shock and Cardiointestinal Syndrome with Impella 5.5 as Bridge to Decision: Case Series

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Cover Page Footnote

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Peer-reviewed Case Series

Management of Patients with Refractory Cardiogenic Shock and Cardiointestinal Syndrome with Impella 5.5 as Bridge to Decision: Case Series

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Abstract

Patients with advanced heart failure require multi-system management as most succumb to end-organ dysfunction, including gastrointestinal sequelae. Temporizing measures, such as early mechanical circulatory support, can assist in the recovery of patients with acute cardiogenic shock. The temporary support can improve patient characteristics to enable future definitive heart failure therapies such as durable left ventricular assist devices and orthotopic heart transplantation. We present two cases of cardiogenic shock that were successfully bridged with an Impella 5.5 (Abiomed). The management enabled the patients to recover from **reversible** cardiointestinal syndrome and undergo successful definitive therapies.

Keywords: Cardiointestinal syndrome, Impella

Background

Patients in "hemometabolic" cardiogenic shock are characterized by severe lactic acidosis and acidemia; they are at high risk for severe shock, multi-organ dysfunction, and reduced survival.[1] In cases of such decreased perfusion, there is reduced blood flow to vital organs, including the mesenteric bed. Furthermore, these patients have significant post-operative complications despite the treatment of heart failure with durable assist devices or heart transplantation.[2]

Different strategies have been successfully used to temporize advanced heart failure, including inotropic support, optimization of pre-load, management of multiorgan dysfunction, and timely mechanical circulatory support

through the femoral vessel. However, these options have the potential for gastrointestinal consequences based on the splanchnic vasomotor response.[3] Inotropic and vasoconstrictor agents may further reduce the blood supply to the gastrointestinal system by increasing splanchnic vascular tone and potentiating gut ischemia. The combination of fluid restriction and diuretic use can cause enterocyte dysfunction.[4] Thus, hypokalemia, as a result of loop diuretics, can further reduce intestinal peristalsis. Cardiointestinal syndrome can also occur in heart failure patients and is characterized by portal venous congestion and splanchnic hypoperfusion with intestinal dysfunction. This ultimately results in severe intestinal dysmotility, edema, inflammation, ischemia with bacterial translocation, and additional myocardial depression.[5]

In addition, mechanical circulatory support utilizing femoral artery insertion precludes patient mobilization, affecting the intestine and colon motility. As a result, constipation, abdominal distention, anorexia, paralytic ileus, bowel edema and distention, malabsorption, constipation, and even bowel perforation could be the spectrum of gastrointestinal manifestations. There is evidence that inadequate splanchnic perfusion in critically ill patients increases morbidity and mortality.[6]

Currently, definitive advanced heart failure therapies include orthotropic heart transplantation and a durable left ventricular assist device (LVAD) implantation. Unlike individuals undergoing elective cardiac surgery, patients with cardiogenic shock who are approved for LVAD implantation represent a special subgroup that may benefit from optimization. Since the implantation of an LVAD requires cardiopulmonary bypass (CPB) support, it is important to consider the associated gastrointestinal complication risk.[7-10] In addition, the postoperative period for patients undergoing durable LVAD surgery requires opioids for pain control, which leads to reduced peristalsis and worsening gastrointestinal distension and exacerbates these conditions in this high-risk group.

There are no specific guidelines for patients in cardiogenic shock experiencing severe gastrointestinal dysfunction and undergoing implantation of a durable LVAD. We present our experience with two chronic heart failure patients diagnosed with refractory cardiogenic shock on both inotropic support and subsequent transfemoral mechanical support that developed significant gastrointestinal dysfunction due to early cardiointestinal syndrome.

Case Descriptions

Patient 1

We present the case of a 33-year-old female with a history of peripartum cardiomyopathy. She has two children, and the last delivery was an uncomplicated caesarian section approximately a year before the current presentation. She has had four prior hospitalizations for advanced heart failure. There is a known family history of non-ischemic cardiomyopathy. The patient was treated medically. She was recently seen during a clinic visit where she presented with New York Heart Association Class IV symptoms. She complained of worsening dyspnea, for which she was admitted to the hospital. The patient suffered from fatigue, dyspnea, and recent constipation that responded to an at-home bowel regimen. Upon physical exam, she was alert and oriented and had signs of jugular vein distension. The abdomen was soft, non-tender, and non-distended, and there was no lower extremity edema. The echocardiogram was significant for depressed left ventricular ejection fraction (< 20%). She had a left ventricular internal dimension in diastole of 6 cm, normal right ventricle (RV), mild mitral regurgitation, and mild tricuspid regurgitation. Pre-hospital abdominal imaging showed moderate to severe narrowing of the celiac axis of uncertain etiology. Results from a right heart catheterization (RHC) done on arrival at the hospital are reported in Table 1. RHC on presentation showed significantly elevated filling pressures with a severely depressed cardiac index (CI) of 0.8 L/min/m^2 in the setting of significantly elevated systemic vascular resistance (> 3000 dynes/sec/cm). Our multidisciplinary team decided the patient was too sick to remain on the transplant list. To escalate her temporary support to ambulatory mechanical circulatory support, an axillary Impella 5.5 (Abiomed) was placed. An aggressive ambulation regimen was initiated with subsequent improvement of ileus and stabilization of debility. She underwent implantation of a HeartMate 3 (Abbott) twenty days after the Impella 5.5 placement (Figure 1). Her postoperative course was complicated by acute, severe right heart failure that required the implantation of a temporary right ventricular assist device (Protek-Duo; LivaNova). The internal jugular approach with a 26 French veno-venous cannulae was used to implant the Protek-Duo. The device was decannulated five days after placement. The patient was discharged to a rehabilitation facility and then home 90 days after presentation. During the recovery period, she had no further episodes of severe intestinal ileus. She continues to manage her heart failure with an LVAD and is regularly seen in the clinic for follow-up care.

Patient 2

A 42-year-old male with a recent diagnosis of non-ischemic cardiomyopathy secondary to extensive cocaine and alcohol use was transferred to our facility from an outside hospital for advanced therapies. He was in stage D cardiogenic shock, as classified by the Society for Cardiovascular Angiography and Interventions. On arrival, the patient noted that he quit alcohol and cocaine within the last year and was hospitalized four times for heart failure. The patient had worsening shortness of

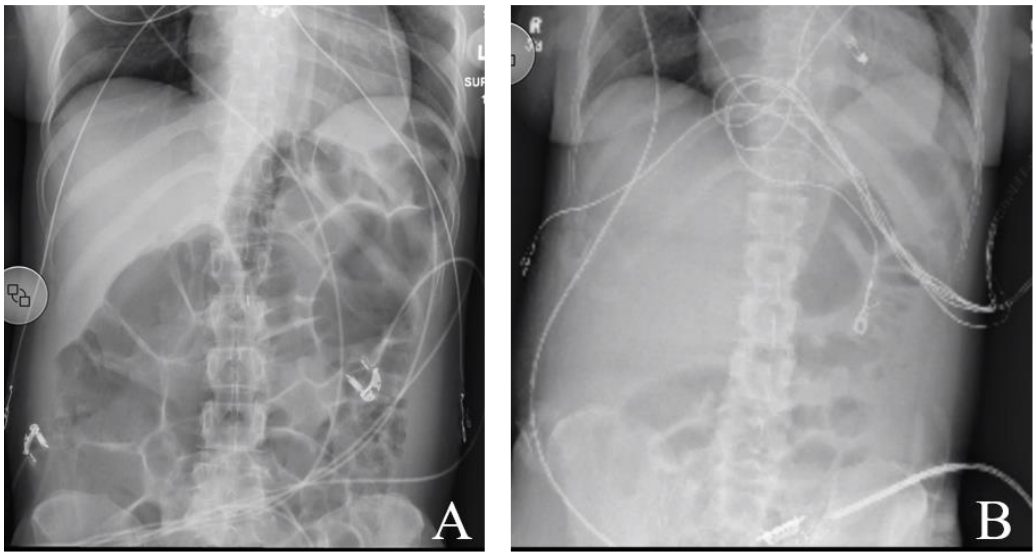

Figure 1. Case 1 Abdominal X-rays A) X-ray taken on the morning of the Impella 5.5 insertion B) X-ray taken on the morning of the left ventricular assist device placement.

breath, fatigue, orthopnea, and paroxysmal nocturnal dyspnea despite adhering to guideline-based medical therapy. He reported no family history of heart failure and was committed to advanced heart failure therapies. Upon physical examination, he was alert and oriented with signs of jugular vein distention, significant pitting edema, and abdominal distension. He had coarse rales and was supported on non-invasive positive pressure with supplemental oxygen therapy. His hemodynamics upon arrival are listed in Table 1.

A left heart catheterization did not reveal any obstructive coronary artery disease. He was initiated on bumetanide infusion and milrinone therapy at 0.375mcg/kg/min. He continued to have signs of low cardiac output; dopamine (2 mcg/kg/min) was added to his medical management. A repeat RHC was done 18 days after admission while the patient received dual inotrope support (Table 1). Given a persistent low cardiac output, a femoral IABP was placed. After social support was established, the patient was presented to the

Table 1. Data collected from right heart catheterizations. For Case 1, no inotrope support was provided on arrival and the repeat data was attained 39 days after admission while the patient was on intra-aortic balloon pump support. For Case 2, the patient was on milrinone (0.25 mcg/kg/min) on admission, and the repeat data was attained 18 days after admission while the patient was on milrinone (0.375 mcg/kg/min) and dopamine (2 mcg/kg/min).

	Case 1		**Case 2**	
	Arrival	**Repeat**	**Arrival**	**Repeat**
Mean right atrial pressure (mmHg)	26	6	22	13
Right ventricular mean pressure (mmHg)	54/22	40/11	51/24	39/14
Pulmonary artery pressure (mmHg)	46/33	38/19	50/30	40/22
Mean pulmonary artery pressure (mmHg)	44	26	37	30
Pulmonary capillary wedge pressure (mmHg)	33	14	33	24
Pulmonary artery saturation (%)	27	70	41	48
Hemoglobin (g/dL)	11.0	12.8	14.2	11.7
Estimated Fick cardiac output (L/min)	1.3	3.8	2.0	2.6
Estimated Fick cardiac index (L/min/m^2)	0.8	2.4	1.3	1.7
Thermodilution cardiac output (L/min)	1.3	NA	NA	NA
Thermodilution cardiac index (L/min/m^2)	0.8	NA	NA	NA

medical review board and deemed to be a reasonable candidate for implantation of a durable LVAD as destination therapy due to substance abuse. A month into the hospitalization, the patient continued to deteriorate despite aggressive diuresis, inotropic support, and multidisciplinary management of cardiac cachexia. He developed intestinal pseudo-obstruction (Figure 2A), and the decision was made to further rehabilitate and stabilize the patient with an Impella 5.5 before implantation of a durable device.

The patient began aggressive physical therapy and ambulation, as well as increased caloric intake. With the continued bowel regimen and mobility, the ileus was resolved on hospital day 38 (Figure 2B). On hospital day 40 (8 days after insertion of the Impella 5.5), the patient underwent placement of a durable LVAD. The postoperative course was unremarkable, and the patient was discharged home on hospital day 58. The patient continues to do well and maintains his follow-up appointments at the outpatient clinic.

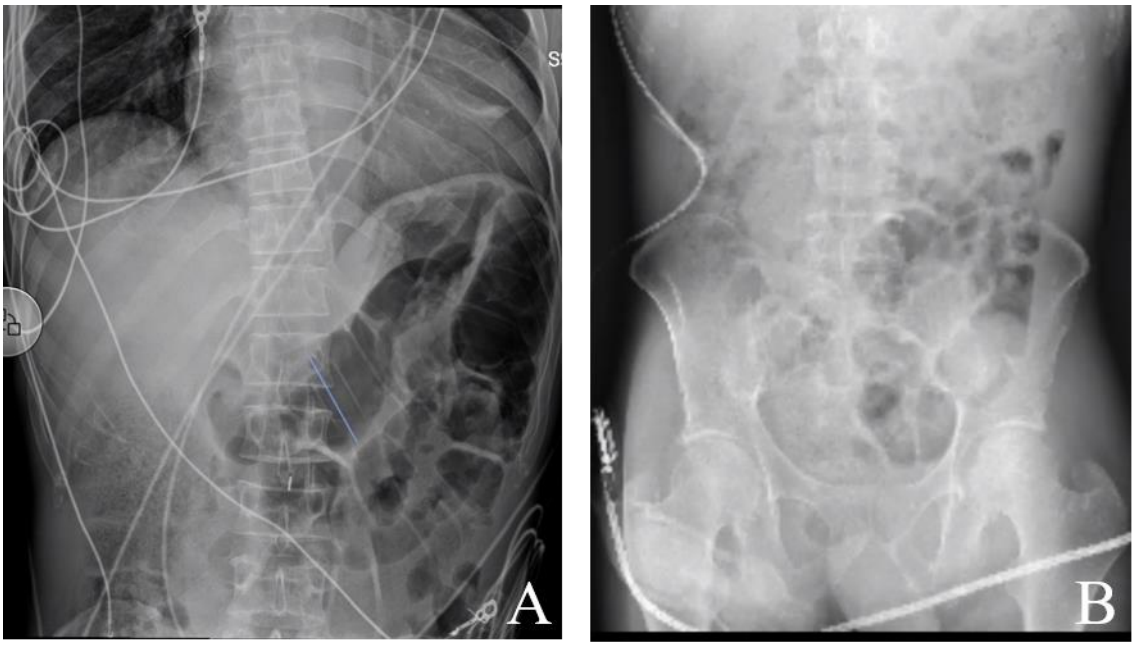

Figure 2. Case 2 Abdominal X-rays A) X-ray taken on the morning of the Impella 5.5 insertion B) X-ray taken on the morning of the left ventricular assist device placement.

Discussion

The current FDA indications to upgrade patients with advanced heart failure to temporary mechanical circulatory support utilizing the Impella 5.5 system include inadequate support to achieve end-organ perfusion.[11] This manuscript describes how to support patients with cardiogenic shock and gastrointestinal dysfunction, likely secondary to reversible cardiointestinal syndrome, via the Impella 5.5 before implantation of a durable LVAD. Gastrointestinal dysmotility, like ileus and pseudo-obstruction, in patients with cardiogenic shock is often viewed as a concomitant gastrointestinal symptom rather than a component of an early and reversible stage of cardiointestinal syndrome. Thus, due to a low cardiac output state, our patients likely had decreased end-organ perfusion with markedly reduced gastrointestinal perfusion and worsening splanchnic vasoconstriction (Figure 3). The trans-axillary Impella 5.5 served as a bridge to the implantation of a durable LVAD with the objective of improving splanchnic circulation, decreasing the amount of inotropic and vasopressors use, and promoting ambulation to improve the gastrointestinal condition.

The cardiogenic shock state is characterized by increased filling pressures with portal and splanchnic venous congestion with subsequent bowel edema, malabsorption, and decreased peristalsis. In addition, the high filling pressures can only be ameliorated with aggressive diuresis therapy, which leads to electrolyte abnormalities that can worsen peristalsis. This combination further exaggerates these complications by decreasing appetite and intestinal absorption and predisposing the patient to a vicious deterioration that eventually leads to an ischemic gut. Finally, the inability to perform ambulation due to trans-femoral mechanical circulatory support further reduces gastrointestinal peristalsis.[12,13] Irreversible consequences include bacterial translocation, bowel

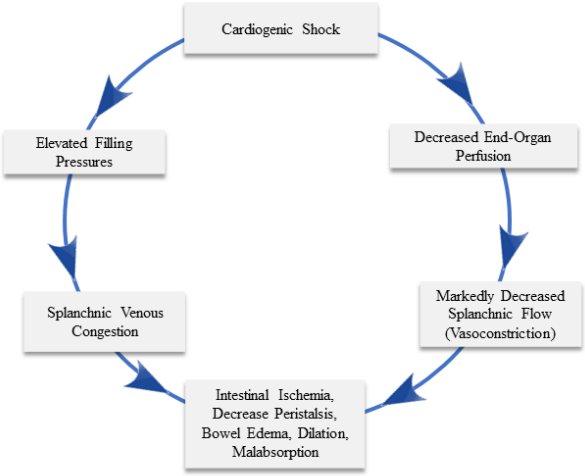

Figure 3. The compounded flow of complications resulting from cardiogenic shock.

perforation, sepsis, and metabolic acidosis leading to further myocardial dysfunction and, eventually, death.

Durable LVADs augment cardiac output, thereby improving end-organ perfusion to all vital organs, including the mesenteric bed;[14] however, patients with pre-existing dysfunction in the gastrointestinal tract may not tolerate CPB support during definitive LVAD surgery. Furthermore, the addition of intraoperative inotropic support and postoperative inotropic and vasopressor support further exacerbate gastrointestinal complications.[15] In addition, patients may need a considerable amount of postoperative narcotic medication for pain control, which can further impair bowel motility.

There are several advantages to using the trans-axillary Impella 5.5 before implantation of an LVAD to improve gastrointestinal dysfunction in patients suffering from cardiogenic shock and cardiointestinal syndrome, as demonstrated in our cases. The ability of the device to provide up to 5.5 L/min of flow is enough to reverse the low-output state resolving the splanchnic vasoconstriction and to improve the forward flow relieving the right-sided elevated pressures. The implantation procedure is a relatively minor surgery without the need for significant narcotic use. Finally, the Impella 5.5 allows for ambulation, which improves peristalsis and optimizes the patient for future definitive durable therapies.

We believe that cardiointestinal syndrome is underdiagnosed in this population until later irreversible stages and want to provide awareness and emphasize that early intervention and resolution of the primary organ dysfunction will likely improve the secondary organ involved. In conclusion, patients with advanced heart failure and multiorgan dysfunction who present with gastrointestinal dysmotility due to a low-flow splanchnic state in the form of cardiointestinal syndrome can be optimized with the Impella 5.5 device. Using this bridge therapy can lead to successfully implanting a durable LVAD or other definitive therapies such as orthotopic heart transplantation.

"Prehab" patients can improve cardiointestinal syndrome, nutritional status, and physical deconditioning to make them suitable candidates for durable LVAD or heart transplant with improved outcomes in an otherwise sick group of patients with very high-risk mortality.

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