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A Case of Acute Renal Failure with Hemolysis Caused by Impella

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Abstract

Background: Some recent guidelines do not recommend the routine use of intra-aortic balloon pumping for patients with cardiogenic shock. Therefore, the use of Impella will further increase as an alternative to intra-aortic balloon pumping for many patients with cardiogenic shock and who are considered to be a high-risk group for percutaneous coronary intervention. However, some serious complications, such as renal failure and hemolysis, have been reported after the use of Impella. We here describe a rare case of acute renal failure with hemolysis caused by Impella.

Case presentation: A 66-year-old male patient presented with cardiogenic shock caused by ST-segment elevation myocardial infarction. We performed early revascularization supported by Impella because his vitals were unstable. The color of his urine turned blackish brown a few hours later, and he developed oliguria. On echocardiography, we found the pigtail catheter tip of Impella to be on the basal posterior wall; however, the device monitor showed no abnormal signs. Laboratory examination showed increased lactate dehydrogenase level, and we suspected acute renal failure with hemolysis caused by Impella. Therefore, we decided to remove the Impella device. Soon thereafter, the color of the patient's urine became clear and his lactate dehydrogenase level improved. He received continuous renal replacement therapy 4 times, and his urinary output gradually increased, and his renal function eventually recovered completely.

Conclusion: We suspected that the main factor worsening the renal function of our patient was hemolysis caused by Impella. A routine echocardiography is useful for detection an improper location of Impella.

Keywords: Impella; Percutaneous left ventricular assist device; Acute renal failure; Hemolysis

Abbreviations: Ao: Aorta; CABG: Coronary Artery Bypass Grafting; IABP: Intra-Aortic Balloon Pumping; ICU: Intensive Care Unit; LA: Left Atrium; LAD: Left Anterior Descending Coronary Artery; LCx: Left Circumflex Artery; LDH: Lactate Dehydrogenase; LV: Left Ventricle; PCI: Percutaneous Coronary Intervention

Introduction

Cardiogenic shock is a highly fatal complication following acute myocardial infarction, even after early revascularization with percutaneous coronary intervention (PCI) or coronary artery bypass grafting. Intra-aortic balloon pumping (IABP) has been the most widely used mechanical support for patients with cardiogenic shock in Japan. However, the IABP-SHOCK II trial showed that there were no differences in the 30-day or 12-month mortality between the IABP group and the conventional treatment group [1]. In addition, there were no differences in the secondary endpoints such as renal function, catecholamine doses, serum lactate level, or duration of treatment in the intensive care unit (ICU) between the two groups [2]. On the basis of these results, routine use of IABP for patients with cardiogenic shock has not been recommended in the European Society of Cardiology revascularization guidelines [3].

Impella (Abiomed Inc., Danvers, MA, USA) is a highly useful tool for stabilizing coronary flow and hemodynamics. Several reports have shown that hemodynamic parameters, such as cardiac output and mean aortic pressure, significantly improved with Impella support compared with the non-use of this device. In patients with cardiogenic shock caused by acute myocardial infarction, Impella support has been shown to have a positive effect on the short-term and long-term outcomes [4]. Therefore, the use of Impella for patients with cardiogenic shock and who are considered to be a high-risk group for PCI has been increasing [5]. In addition, the Protect II trial showed that support with Impella 2.5 during high-risk PCI tended to improve outcomes after procedures compared with support with IABP [6].

However, some reports showed that placement of Impella can result in serious complications such as sensor failure, functional mitral stenosis, and local vascular complications, including bleeding and limb ischemia [4,7-11]. Specifically, secondary hemolytic anemia is a main complication of improper placement of Impella 2.5. However, the association between hemolysis due to Impella and acute renal failure is unclear. We here describe a case of acute renal failure suspected to be caused by Impella 2.5-induced hemolysis.

Case Presentation

A 66-year-old male patient with no medical history visited our hospital because of sudden faintness. His vital signs were checked on arrival, and his heart rate was 37 bpm, his blood pressure was 90/38 mmHg, and he had cold sweat. Electrocardiography revealed ST elevations in leads II, III, and aVF, with complete atrioventricular block. Echocardiography showed severe hypokinesis of the inferior region. We diagnosed precardiogenic shock due to ST-segment elevation myocardial infarction with complete atrioventricular block and performed an emergent revascularization.

Coronary angiography after placement of the temporary lead showed 99% stenosis in the left circumflex artery (LCx) and 90% stenosis in the left anterior descending coronary artery (LAD) with severely low perfusion (Figure 1). The right coronary artery was hypoplastic. While the patient was undergoing coronary angiography, his blood pressure dropped,

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and cardiogenic shock developed. Owing to a severe coronary lesion and unstable hemodynamic, we immediately inserted Impella through the patient's right femoral artery. We decided to initially perform revascularization from the LCx. We performed thrombus aspiration and balloon dilation followed by placement of a drug-eluting stent. We placed a drug-eluting stent in the LAD after balloon dilation. We completed the procedure, and thrombolysis in myocardial infarction (TIMI) flow with Grade III was achieved in both LCx and LAD. On fluoroscopy and echocardiography, we confirmed that Impella was placed in the direction of the left ventricular apex. The patient's blood pressure had improved on completion of the procedure. The patient was transferred to the ICU after the procedure. His hemodynamics including mean aortic pressure was stabilized and his lactate level was improving owing to the placement of Impella. chocardiography revealed that his left ventricular contraction was almost good although severe hypokinesis of the inferior region remained (Figure 2). However, a few hours later, his urine turned blackish brown and he developed oliguria (Figure 3). Laboratory examination showed increased lactate dehydrogenase (LDH) level (Figure 4).

Furthermore, echocardiography showed that the pigtail catheter tip of Impella was sitting on the basal posterior wall. Although we attempted to insert Impella in the direction of the left ventricular apex under echocardiographic guidance, it was difficult to insert the device in a sufficiently appropriate location. Because the device monitor showed no abnormal signs, we decided to observe carefully with dobutamine and noradrenaline infusions. Although the patient's hemodynamic parameters were preserved, his oliguria was not improved and the LDH level was significantly increased. We suspected renal failure caused by hemolysis as a complication of Impella. We confirmed that left ventricular wall hypokinesis and lactate were showing an improving trend, and Impella was removed approximately 12 hours after its insertion. The color of the patient's urine became clear and his

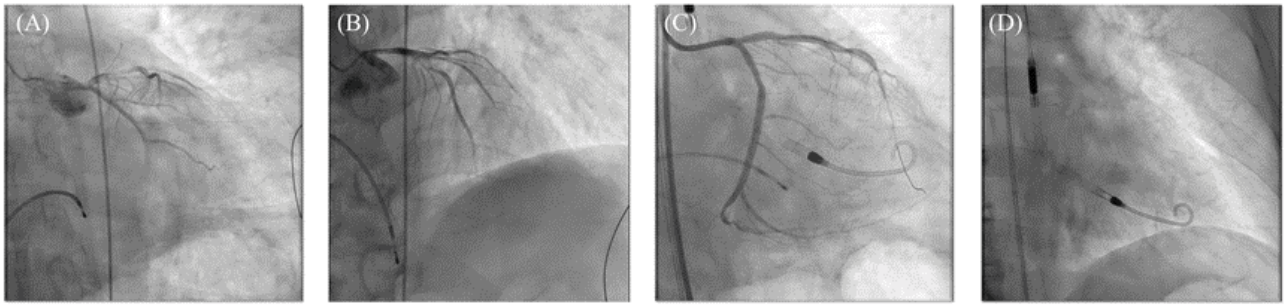

Figure 1: Coronary angiography and percutaneous coronary intervention. (A) Caudal view; (B) Cranial view; angiogram revealing 99% stenosis in the left circumflex artery (LCx) and 90% stenosis in the left anterior descending coronary artery (LAD) with severely low perfusion; (C) Placement of a drug-eluting stent in the LAD and LCx with Thrombolysis in Myocardial Infarction 3 flow; (D) Insertion of Impella 2.5 in the left ventricle.

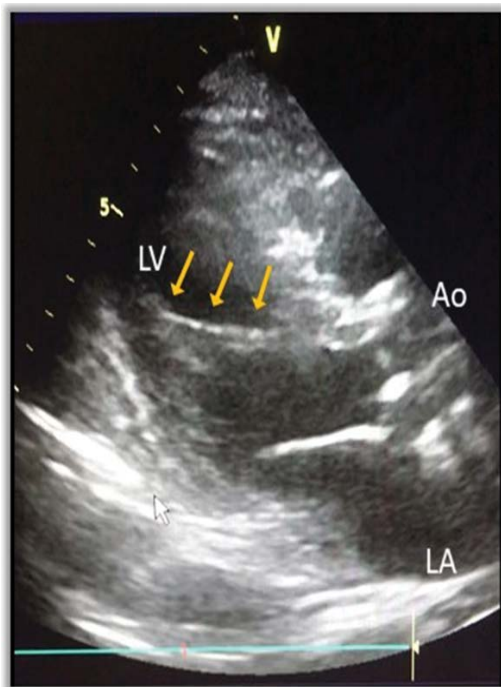

Figure 2: Parasternal long-axis view showing that the Impella device was located on the inferior wall (Yellow arrow); LV: Left Ventricle; LA: Left Atrium; Ao: Aorta.

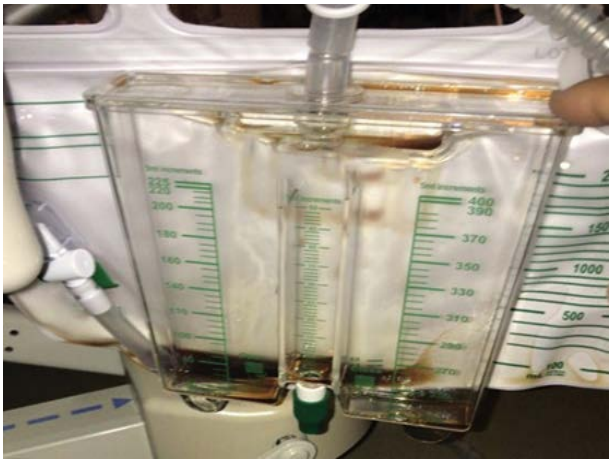

Figure 3: The color of the patient's urine turned blackish brown a few hours later, and he developed oliguria.

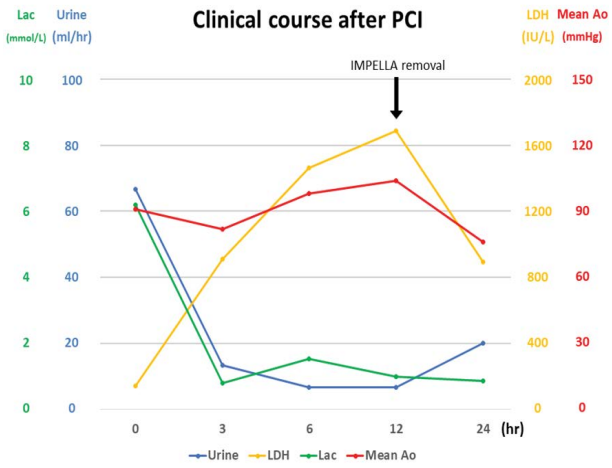

Figure 4: Clinical course after percutaneous coronary intervention (PCI). The patient's hemodynamic parameters were preserved after the PCI procedure; LDH was improved after the removal of Impella 2.5. Lac: Lactate; LDH: Lactate Dehydrogenase; Mean Ao: Mean Aortic Pressure.

LDH level immediately improved. His hemodynamic parameters were almost unchanged. However, the results of laboratory examination showed increased levels of blood urea nitrogen and serum creatinine. He received continuous renal replacement therapy 4 times, and his renal function gradually improved from the 21st day of hospitalization.

Discussion

We encountered a case in which the patient developed acute renal failure as a complication associated with mechanical hemolysis caused by Impella. In this case, we noticed two important clinical issues:

(ı) We suspected that the main factor worsening the renal function of our patient was hemolysis caused by Impella.

(ıı) Routine echocardiography is useful for detection the improper location of Impella.

First, we suspected that the main factor worsening the renal function of our patient was hemolysis caused by Impella. Previous reports showed that hemolysis occurs at a frequency of about 8% [4,7-11]. However, there are no published cases of acute renal failure due to hemolysis caused by Impella. Intravascular hemolysis is often attributed to iatrogenic abnormal shear force. In their case report, Markakis et al. demonstrated that mechanical hemolysis can cause acute renal failure [12]. In our case, the patient had low cardiac output and there is a possibility of low perfusion-induced kidney failure. However, the influence of low perfusion could be limited because the vital signs after hospitalization in the ICU was stable with the use of noradrenaline and dobutamine, and no signs of circulatory insufficiency were observed on a blood test. On the basis of the above findings, we consider that the acute renal failure in this case may be attributed to hemolysis due to Impella.

Second, routine echocardiography is useful for detection the improper location of Impella. Some reports found that malpositioning of the Impella device results in hemolysis, and Cardozo et al. reported that removal of Impella resulted in improvement and resolution of hemolysis under echocardiographic guidance [13,14]. In our case, we frequently checked the location of Impella by using echocardiography, which revealed that the Impella device was on the posterior basal wall.

If an Impella device is placed in an improper location and causes hemolysis, it would be a matter of debate whether or not immediate removal is necessary. There is a concern that removing Impella under unstable hemodynamics can accelerate circulatory failure and induce organ disorders. However, leaving mechanical hemolysis unmanaged can accelerate acute renal failure and cause worsening of cardiac failure and, eventually, multiorgan failure. In this case, we judged that the hemodynamics exhibited an improving trend because the lactate level was improving. Therefore, we decided to remove Impella immediately. After the placement of Impella, its location should be checked periodically under echocardiography, and an attempt should be made to insert the device in the proper location as much as possible. If hemolysis still does not improve and renal failure progresses, removal of Impella should be considered after the patient's hemodynamics are thoroughly checked based on vital signs, physical findings, and test parameters.

Conclusion

As Japanese people have a smaller physique with smaller heart chambers and left ventricular outflow tracts than the European and American populations, we speculate that an Impella catheter tends to come into contact with the cardiac wall surface and the mitral valve in Japanese patients. Therefore, it is possible that hemolysis caused by Impella has a higher probability to occur in Japanese patients than in European and American patients. When placing Impella in patients with a small physique, in elderly female patients, or in patients with severe cardiac hypertrophy, particular attention should be paid to mechanical hemolysis. It is important to periodically check the location of Impella and removal of the device should be considered after a strict investigation of the patient's general condition. We suspected that the main factor worsening the renal function of our patient was hemolysis caused by Impella. It is crucial to regularly check the position of Impella, and removal of the Impella device should be carefully considered according to a strict investigation of the patient's general condition.

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