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Techniques of Impella removal while preserving arterial access☆

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ABSTRACT

Preservation of the arterial access site after removal of large caliber mechanical circulatory devices (MCD) can be challenging. In this paper, we describe two novel techniques and review the current literature focusing on the maintenance of arterial access after Impella removal.

Contents

1. Introduction

Cardiogenic shock (CS) represents a major cause of in-hospital mortality and is secondary to a variety of acute and chronic pathologies, the most common of which are acute myocardial infarction (AMI) and chronic cardiomyopathic diseases [1]. It is accompanied by a state of organ dysfunction secondary to poor cardiac output (CO) as a result of ventricular failure [2]. With the increased incidence of CS complicating AMI, high in-hospital mortality persists as high as 50% during the same time period, and the use of MCDs has increased steadily [3–5]. While a causal association between increased use of MCD's and improved outcomes in CS patients has not been described, improving CO may allow for enough ventricular unloading and end-organ stabilization to improve outcomes in CS. The Impella (AbioMed, Danvers, MA) is a continuous, nonpulsatile, axial flow Archimedes-screw pump that provides active LV support by aspirating blood from the LV and expelling it into the aorta [2]. There are three commercially available versions of the Impella for LV placement: the Impella LP 2.5 that can deliver up to 2.5 L/min of CO, the Impella CP that can deliver up to 3.7 L/min of CO, and the Impella LP 5.0 that can deliver up to 5.0 L/min of CO. While the first two may be inserted percutaneously using 12–14 F sheaths, the Impella LP 5.0 requires surgical cut down of the femoral or axillary artery prior to insertion of a 22-Fr sheath [2]. The use of Impella provides superior hemodynamic support when compared with the intra-aortic balloon pump (IABP) but a benefit in hard-outcomes has not been definitively demonstrated [5–7]. Device related complications include bleeding, infection and hemolysis [2] and often necessitate device removal. We have previously described a technique for delayed endovascular hemostatic closure of large bore vascular access sites [8], however access preservation may allow for the effects of the concomitant systemic anticoagulation to dissipate in order to reduce the risk of bleeding during sheath removal. Furthermore, replacing the Impella with another hemodynamic support device such as an IABP, Tandem Heart, or ECMO may be required. The current generation Impella sheath does not allow preservation of the access site with direct guidewire placement when there is a need for device removal. In this paper we

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describe two cases using different techniques to maintain vascular access upon removal of the Impella device.

2. Case 1: sheath in sheath technique

A 56-year-old male with dilated alcoholic cardiomyopathy was transferred to our hospital with the diagnosis of CS. An Impella CP was placed at the outside hospital with hemodynamic improvement. Electrical instability ensued with multiple runs of ventricular tachycardia requiring synchronized cardioversion secondary to Impella interaction with the mitral subvalvular apparatus. After the last successful cardioversion, the Impella catheter was dislodged into the aorta. There was slow deterioration in the hemodynamics after dislodgement, necessitating continued mechanical hemodynamic support. The decision was made to remove the Impella catheter and replace it with an IABP with fluoroscopic guidance in the catheterization lab. In this approach, the Impella shaft will ultimately act as the guidewire for a larger sheath after removal of the re-positioning sheath. The equipment is illustrated in Fig. 1. The Impella shaft was cut at the 100 cm mark with serrated scissors (Fig. 2) and the 14-French Impella repositioning sheath was removed. Next, a 9-French sheath was inserted into a 12-French sheath (Fig. 2-b) to act as a dilator over the Impella shaft "guidewire". After removing the 9 F sheath and keeping the 12 F sheath in place, a stiff 0.035-inch wire was then advanced through the 12 F sheath, next to the Impella shaft, into the ascending aorta. The Impella and 12 F sheath were then removed and a new 14 F sheath was advanced over the stiff wire and secured into place. The IABP was then inserted using the usual technique. Table 1 summarizes the first technique.

3. Case 2: wiring the Impella outlet

A 63-year-old male with multivessel coronary artery disease (CAD) requiring recent percutaneous coronary intervention (PCI) to the left anterior descending artery (LAD) was admitted with CS. An Impella 2.5 was left in place after a complex, multivessel PCI, however the Impella waveform and position were not optimal 24 h later in the intensive care unit despite repositioning under echocardiographic guidance. The low mixed venous oxygen saturation (40%) necessitated continuation of hemodynamic support. The decision was made to remove the Impella and replace it with an IABP.

In this approach, the Impella was pulled back under fluoroscopy into the distal part of the common femoral artery. The Impella repositioning sheath was removed over the shaft of the Impella, while the second operator applied firm pressure. The Impella was retracted out of the body until the outlet was exposed (Fig. 3). A stiff 0.018-inch × 190 cm wire was advanced through the Impella outflow into the iliofemoral artery and placed in the thoracic aorta. The Impella was removed out of the body over the wire. A 5 F dilator was inserted over the stiff wire to maintain access into the common femoral artery. The 0.018-inch wire was exchanged for a stiff 0.035-inch wire and placed distally in the aorta. The 5 F dilator was then removed and a 12 F sheath was advanced over the stiff 0.035-inch wire. The IABP was then inserted using the usual technique. Table 2 summarizes the second technique.

4. Discussion

In this paper we have described two different techniques to preserve vascular access following the removal of the Impella device. Several reports have been described in the literature with innovative techniques.

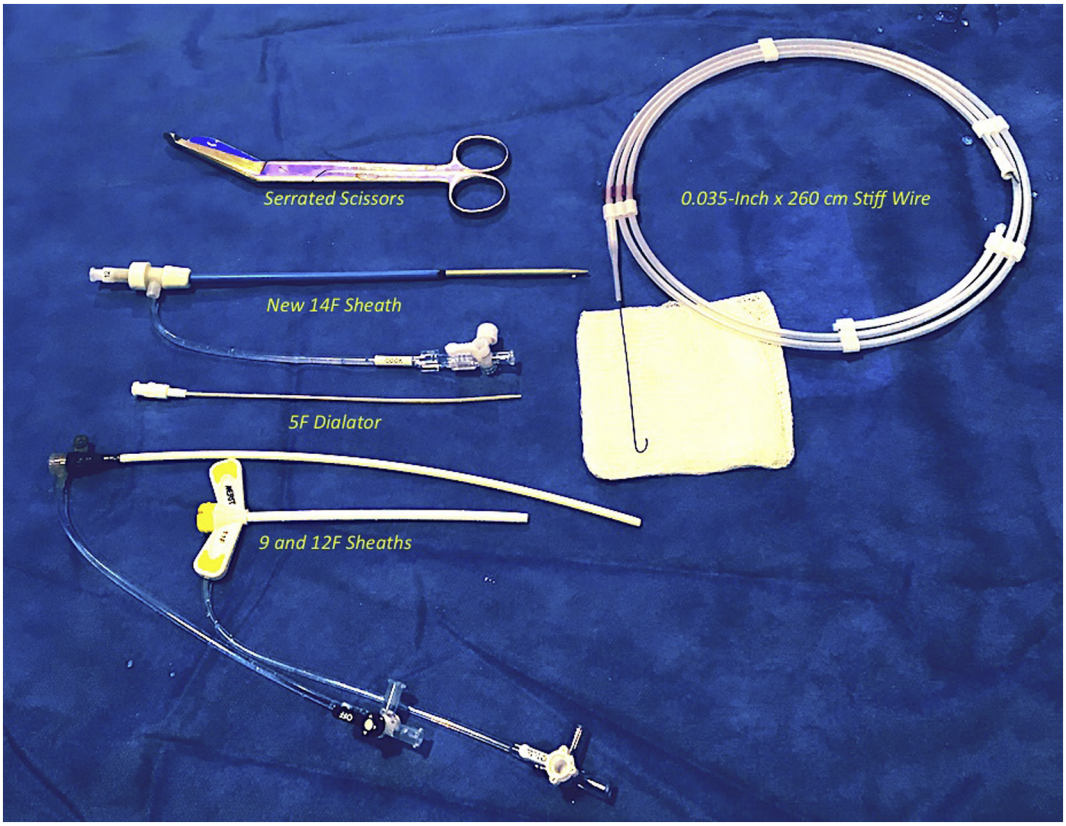
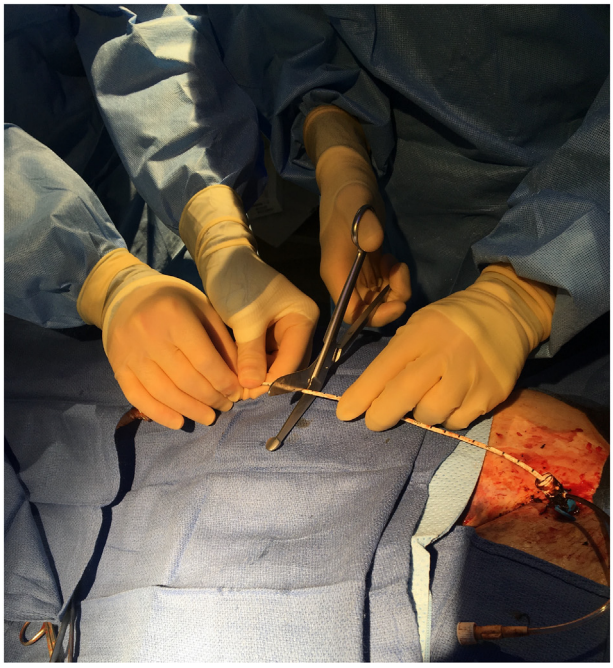
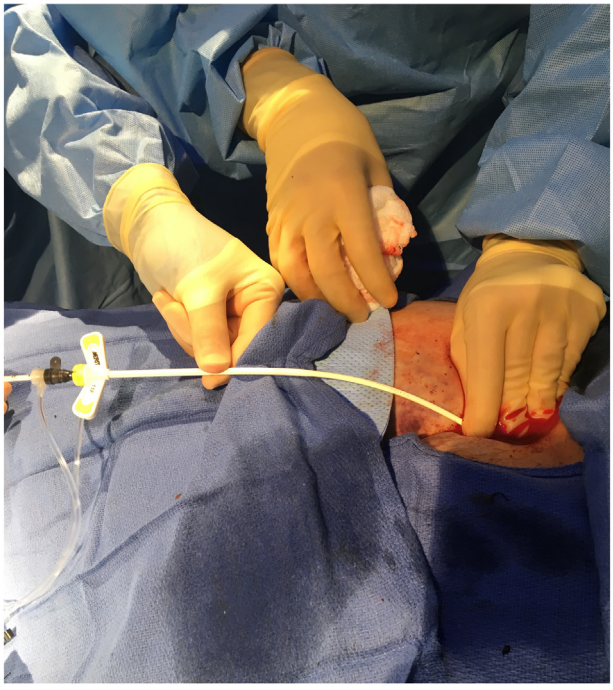


Fig. 1. Equipment needed.



a



b

Fig. 2. A: Cutting the Impella shaft. B: Insertion of 9 F and 12 F sheaths over Impella body.

In a case described by Khachatryan and colleagues [9] the Impella was retracted to the 30 cm marker and using a scalpel, a 1 cm long slice was made at the 40 cm marker. A circumferential cut was made at the 105 cm marker, and a 0.018 J-Tip guidewire was back-loaded through the 40 cm marker, exiting the 105 cm marker with the J-tip kept inside the proximal cut. This allows for the creation of a rapid exchange system. The Impella then is advanced into the body to the 60 cm marker; at this point, the wire is advanced from the back end, allowing it to exit into the aorta at the 40 cm marker. The Impella, as well as its sheath, are removed in rapid exchange fashion in order to maintain wire access, and a new sheath is introduced over the same wire. This technique may carry an increased risk of infection with reintroduction of the Impella catheter into the body.

Table 1
Technique 1 (sheath in sheath).

1. Turn the Impella off and retract the device to expose the 80 cm marker.
2. Cut the Impella shaft at the 100 cm marker using serrated scissors.
3. Insert a 9-French sheath into a 12-French sheath (the 9-French dilator is needed for support and can then be removed).
4. While maintaining Impella position, completely retract the repositioning sheath.
5. Fully insert the 9/12-French sheath system over the Impella shaft and remove the 9-French sheath.
6. Advance a stiff 0.035-inch wire through the 12-French sheath, next to the Impella shaft, into the aorta (use of a 5-French dilator as a wire introducer may be necessary).
7. While maintaining wire placement in the aorta, remove the Impella and the 12-French sheath.
8. Insert new 14-French sheath.

Phillips and colleagues [10] have described the "Trojan Horse" technique. In this method the catheter is withdrawn to the descending aorta and the repositioning sheath is pulled over the catheter (while a second operator maintaining firm pressure on the arteriotomy site). The Impella is retracted out of the body until the 35 cm marker is exposed. Using a percutaneous access needle, a puncture is made at the 35 cm marker over the hash marks in order to enter the flush lumen. A 0.018 J-Tip guidewire may then be advanced through a wire introducer until it reaches the proximal port. The Impella is then readvanced to the aortic valve to deliver the wire to the aorta. The Impella catheter and sheath may then be retracted in a rapid exchange fashion to maintain wire access in the aorta and allowing placement of a new sheath. Similar to the case above, the reintroduction of the Impella catheter device into the body may increase the risk of infection.

In another technique described by Cook and colleagues [11], the Impella is cut proximally using a wire cutter and the sheath was removed over the catheter to maintain access. A new ABIOMED 14-F sheath is cut distal to the catheter introducer assembly and slid over the Impella. A 0.035 wire is advanced through the sheath passing alongside the Impella. The wire is maintained in the aorta while the Impella and the sheath were removed. This technique requires a new 14-F Impella sheath, which may not be readily available apart from opening a new Impella kit. Furthermore, introducing a 14-F non-tapered sheath through the Impella catheter (9 F) could theoretically carry a risk of injuring the arteriotomy site, as the assembly is similar to advancing a sheath over a guidewire without a dilator.

In our "sheath in sheath" technique we allow the safe introduction of the 12F sheath over the Impella using a 9F sheath that is removed soon after the 12 F sheath has reached the arteriotomy site. This technique presents a low risk of infection and bleeding, as the Impella is not reintroduced to the body as described in the techniques above. "Wiring the Impella outlet" technique may be used as a bailout when complications ensue, but may be associated with significant risk of bleeding from the outlet and the risk of losing access. The combination of these two techniques allows for a primary and a back-up plan in any situation in which maintaining vascular access is desired upon removing the Impella device.

5. Conclusion

Maintaining vascular access after removal of the large caliber Impella catheter and sheath may be critical in select cases. In these cases we summarize different techniques for safe removal of a percutaneously placed Impella system while preserving the access site for further use or delayed closure.

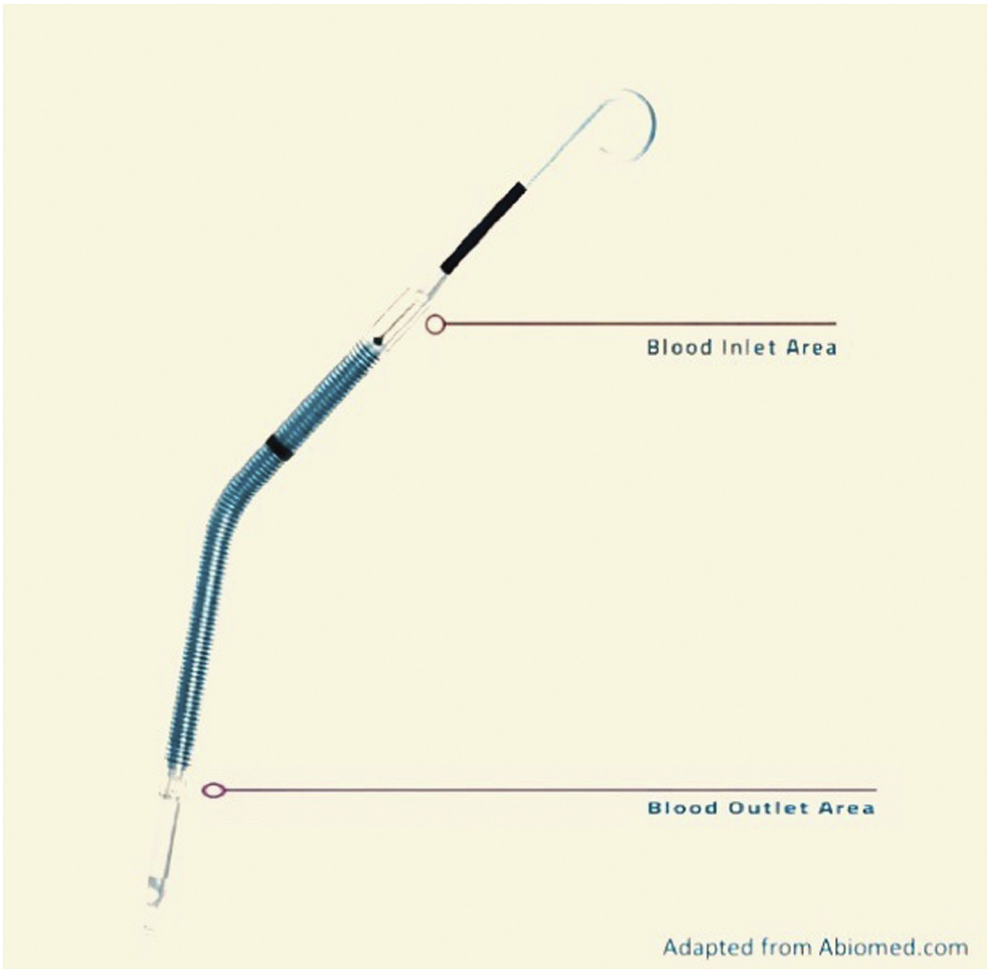


Fig. 3. Impella outlets:

Table 2
Technique 2 (wiring the Impella outlet).

1. Turn the Impella off and retract to the distal segment of the common femoral artery.
2. While one operator applies manual pressure, remove the sheath over the Impella shaft.
3. Moving quickly, retract the Impella out of the body until the outflow is exposed and advance a stiff 0.018-inch × 190 cm wire through the outflow up to the thoracic aorta.
4. Retract the Impella and wire together until the Impella is completely removed and the wire shaft can be controlled outside the body.
5. Fully remove the Impella from the wire and insert a 5-French dilator over the stiff wire to maintain access.
6. Exchange the 0.018-inch wire for a stiff 0.035-inch wire.
7. Remove the 5-French dilator and insert a new large sheath over the stiff 0.035-inch wire.

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