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EDITORIAL COMMENT

Snaring Victory from the Jaws of Defeat*

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In this issue of *JACC: Case Reports*, Alhasan et al[1] describe their management of a patient with submassive bilateral pulmonary embolism (PE) using catheter-directed thrombolysis. Unfortunately, the patient then experienced progress to right ventricular (RV) failure and cardiogenic shock, prompting escalation to RV mechanical circulatory support (MCS) with the Impella RP device (Abiomed).

Recognition of acute RV failure is important because it is a major determinant of clinical severity and outcomes.[2] The use of MCS devices can make a critical impact in such scenarios and is recommended as a final rescue step in current PE rescue team (PERT) treatment algorithms.[2,3] Common percutaneously delivered RV MCS options currently include extracorporeal membrane oxygenation, the micro-axial flow pump-based Impella RP catheter, and double-lumen single-cannula based devices such as the ProtekDuo (LivaNova) and the Spectrum Medical dual-lumen cannula (Spectrum Medical). In the choice between these options, attention should be paid to differences in approved indications, implantation durations, and device-specific technical nuances.[4] Ideally, considerations surrounding access size and approach (eg, femoral vs internal jugular), location(s) of concomitant thrombus burden, and ability to oxygenate through the circuit should also be carefully weighed. More realistically, however, the choice of MCS is often dictated by institutional availability and operator expertise.

As described, an Impella RP device was advanced via the right femoral vein and fractured just distal to the outlet cage, while being torqued to enable advancement beyond the right ventricular outflow tract (RVOT). The ensuing successful percutaneous rescue deserves special attention. As noted by Alhasan et al[1], an analysis of the Manufacturer and User Facility Device Experience (MAUDE) showed a device detachment rate of 8.6%.[5] A more detailed description of these device detachments (ie, location, mechanism and circumstance in each reported case) is not provided. It is important to note that the MAUDE registry is an FDA-maintained database that houses medical device reports of suspected device-associated adverse events. As this database provides passive surveillance, it is not intended to be used to evaluate rates of adverse events. Nevertheless, with the ever-growing utility of complex medical devices in interventional cardiology, such registries may provide valuable insights into potentially recurrent device-related complications. Given the nature of this type of complication, every device detachment event requires consideration of the mechanism of failure and case specific detail before launching a rescue effort. Still, despite the unique nature of each case, certain 'standard wisdom' may apply (**Figure 1**).

In this case, the 0.018-inch guidewire was still in place distally at the time of device fracture, as shown in the authors' Video 1. As soon as fracture is recognized, maintaining guidewire position becomes critically important. Without it, one less point of friction is present to prevent distal embolization of the pigtail fragment, which would make an already precarious clinical situation even worse. Maintaining and/or re-establishing guidewire position is similarly prescribed in modern percutaneous rescue algorithms of percutaneous coronary intervention complications.[6] The proximal fractured segment can be removed at this point (if possible without guidewire disruption) to create

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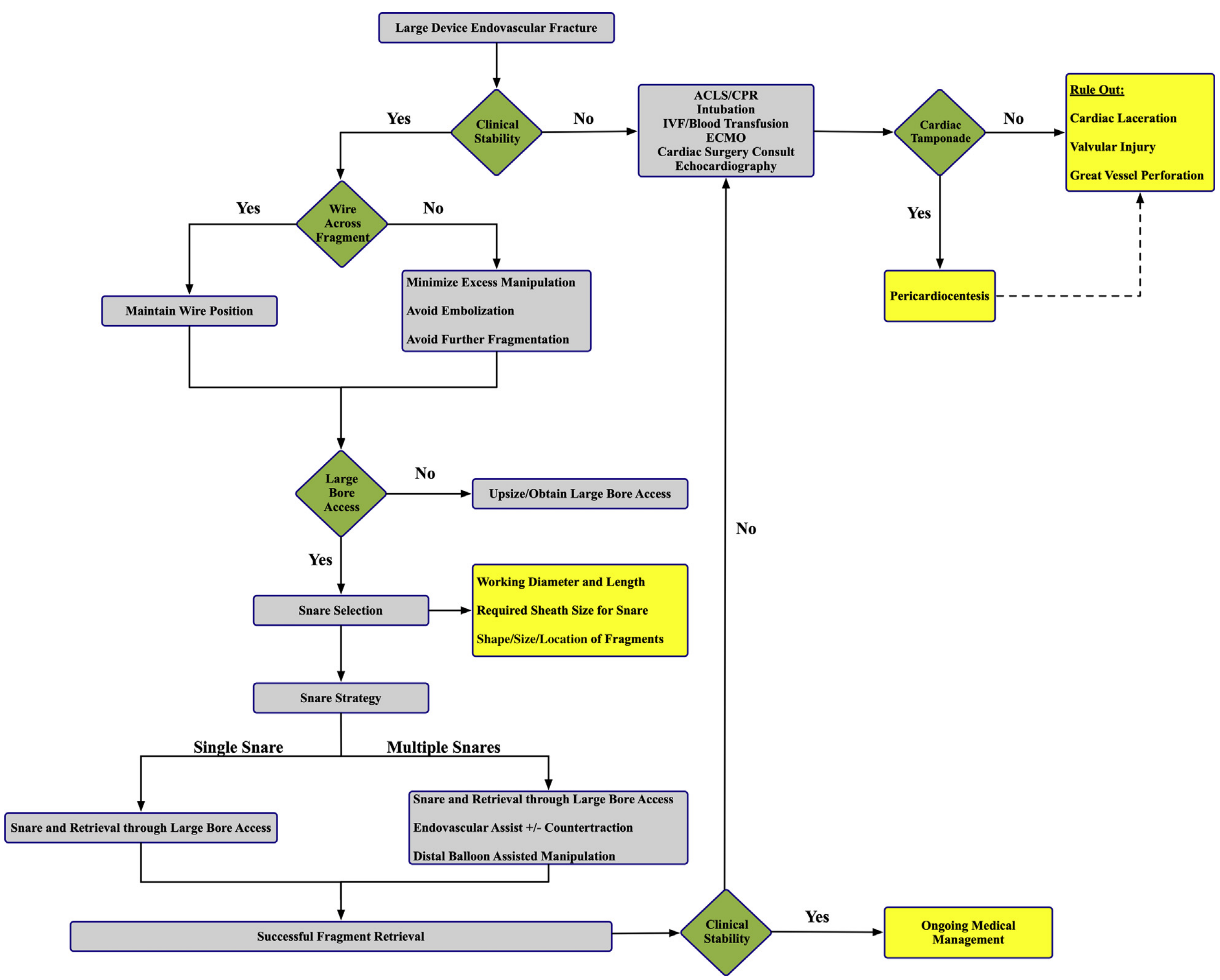
room for retrieval through existing large-bore access.

The next step used by Alhasan et al[1] was to place a 0.014-inch coronary workhorse wire adjacent to the fractured equipment to support the entry of a snaring system. Although this is sound strategy, acknowledged in this decision is that the patient remained in a hemodynamically stable condition during this course. In such scenarios, close attention ought to be paid to blood pressure, and a high index of suspicion should be maintained for the possibility of perforation. In the setting of sudden hemodynamic collapse, emergent escalation to extracorporeal membrane oxygenation should immediately be considered, as well as emergent echocardiography to rule out tamponade, cardiac laceration, and valvular injury.

In this case, a 15-mm Amplatz gooseneck snare (Medtronic) was used to retrieve the distal pigtail fragment. Appropriate snare selection in these types of scenarios deserves some consideration and can often form the difference between a quick success or a difficult grind. The main determinants of snare selection are the working diameter of the snare device, snare length, and the catheter size required for its delivery. The most efficient strategy is to advance the snare system through the same sheath through which externalization is intended (assuming the sheath is large enough to accommodate the snare and to capture the snared fragment). To some extent, the shape, mobility, and location of the target fragment should also be considered. For instance, snaring a fairly stationary pigtail fragment in the RVOT may be reasonably well served with a circular goose snare,

FIGURE 1 Percutaneous Rescue of Large Device Endovascular Fracture



inasmuch as it could theoretically conform to the ovoid shape of the RVOT and thus allow encircling/capturing of the pigtail fragment (provided the snare working diameter is large enough). Alternatively, capturing a mobile fragment in the right atrium or RV may be better served with a large system with multiple overlapping loops such as the Ensnare (Merit Medical). Beyond simple snaring techniques, further escalations such as the use of multiple snare devices or distal balloon assisted manipulation can also be considered.[7] The use of multiple snares is sometimes considered when an "endovascular assist" is thought to be necessary or when countertraction is needed to untangle embolized fragments of the device.[8] For right-sided embolizations, countertraction maneuvers could be performed by advancing a second snare system via the internal jugular or inferior vena cava vein, depending on the position of greatest mechanical advantage.

Once a fractured segment is successfully captured, retrieval into a large-bore sheath often requires clumsy and unpredictable intravascular manipulation. Again, a high index of suspicion should be maintained for the possibility of perforation. In the featured case, the presence of the 23-F peelaway sheath was advantageous because the sheath tip was large enough to easily capture the pigtail fragment. Had that not have been the case, the authors might have considered upsizing their sheath before making a snaring attempt. Alternatively, had the 23-F peelaway sheath already been removed and replaced with the inline 11-F repositioning sheath, large-bore access via the contralateral femoral vein would perhaps have been necessary. Large-bore access is generally desirable, so it may easily engulf the captured fragment even if folded in an awkward fashion.

During fragment removal, the authors noticed a kink in the original 23-F peelaway sheath (Video 3 in Alhasan et al[1]). It is possible that the sheath kink pinched the proximal shaft with enough resistance to cause a twist deformation in the distal portion of the device with continued application of torque (leading to separation via an unscrewing mechanism). Another factor may have been that device delivery was attempted over a 0.018-inch guidewire (a 0.027-inch guidewire is a standard provision with Impella RP packaging). In retrospect, optimization of guidewire support could have been considered. Whether a device=specific defect also played a role is currently under investigation.

Advancements over recent years have brought forth the advent and maturation of specialist teams such as PERT and shock teams. But, as highlighted here, cross-team training is just as important as cross-team collaboration. With the growing technical complexities of our field, it is likely that each of us will occasionally find ourselves in uncharted territory, where improvising on a borrowed trick may become necessary. It is in these situations that personal creativity, intuition, and fortitude form the difference between success and failure. Much is said about the "art of medicine." Cases like these exemplify what that looks like in real-life practice.

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