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Using a Virtual Reality Trainer to Prepare for Difficult Cases

With a difficult MI case, you might have a few minutes to save a life. That is a few minutes to choose and navigate a guidewire and catheter, take arteriograms, find the lesion, dilate, and place a stent. Practicing on a simulator before you are actually faced with a life-threatening case is an ideal way to help you become prepared.

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A 58-year-old hypertensive female smoker presents via ambulance with retrosternal chest pain radiating to both arms with associated dyspnea and diaphoresis. ECG on arrival demonstrated significant ST elevation in leads V5 and V6.

This is a case description from Immersion Medical's CathLabVR™ system. Working through this case on the simulator, if you do not act quickly and with a high degree of skill, the patient will die. But, the good news for cardiac interventionists is that, using today's medical simulators, you will be better prepared for real-life cases. By stepping through the case, one of many designed for the CathLabVR™ system, this article explains how interventionists can help prepare themselves for even very difficult cases, and how the use of these simulators is being implemented and evaluated in intensive training of novice clinicians.

Our US-based teaching faculty has taken advantage of this simulation system over the past several years while conducting extensive interventional training programs in China. Although the Chinese interventionists enjoyed the didactic lectures and the video case reviews, clearly the most valuable tool was the hands-on learning provided through the simulation experience. We were able to work one-on-one with our Chinese physicians and communicate ideas and techniques to help further develop their technical skills.

THE OPERATING THEATER

The quality of simulation of a catheterization laboratory environment is incredible. The virtual reality CathLabVR™ system mimics the functionality of a real catheterization lab and simulates the responses of the virtual patient. The physician-operator is presented with choices similar to those encountered when performing cardiac catheterization and percutaneous coronary intervention. Guiding catheter, guidewire, balloon, and stent choices are available, providing an equipment decision pathway quite similar to what we encounter when performing live cases.

The system platform fills roughly the same space as would a real patient, and a foot pedal, keyboard, mouse, and two monitors are included. The foot pedal is used to capture cine and control fluoroscopy; other system functions are controlled using a joystick to maneuver the simulated C-arm, and a keyboard and mouse to make onscreen selections.

The primary (right) monitor displays fluoroscopic and real-time navigation views as well as simulated patient information, including aortic pressure, heart rate, respiratory rate, oxygen saturation, ECG strips, and catheter tip pressure wave.

The secondary (left) monitor displays physiologic, cine, and still images and controls for the C-arm/table glyph. The physiologic view displays the 3D model of the aorta (descending, arch, and ascending), native coronary arteries, and in some

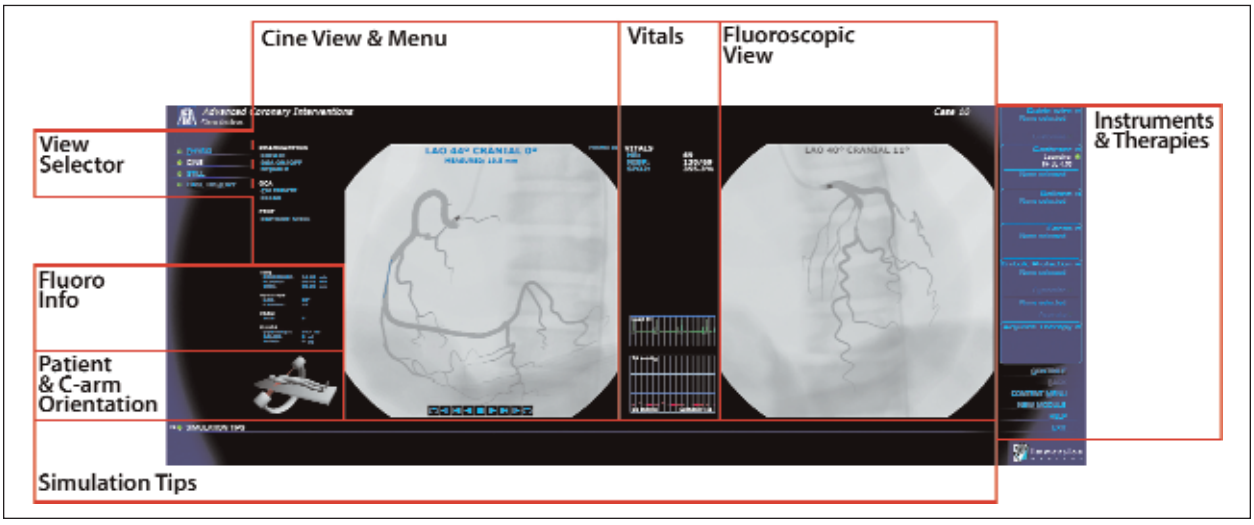

Figure 1. Two side-by-side monitors allow the patient's vital signs and cine and fluoroscopic views to be available simultaneously. The anatomy beats in rhythm with the virtual patient's pulse.

instances, saphenous vein grafts. The anatomy beats in rhythm with the virtual patient's pulse, and rises and falls according to the patient's breathing. The secondary monitor also displays total procedure running time, fluoroscopy and cine radiation time, and contrast instilled (Figure 1).

PREPROCEDURE

After selecting this particular acute MI case, the screen displays a static frontal fluoroscopic view of the heart. For this case, you will note the following steps have already been performed, allowing you to begin the procedure immediately:

- Informed consent has been obtained
- Baseline ECG, electrolytes, renal function, complete blood count, and coagulation parameters have been reviewed and are within normal limits
- Nothing by mouth status confirmed
- Appropriate antiplatelet agents have been administered
- Adequate anticoagulation for PCI has been administered
- Intravenous access has been obtained, and adequate conscious sedation is established
- Physiologic monitoring has been initiated
- Femoral artery access has been obtained
- A femoral sheath has been inserted into the artery over a guidewire, and a heparin bolus has been administered through the sheath
- All the tools and accessories have been inspected and are in good working order

THREADING DIAGNOSTIC GUIDEWIRE AND CATHETER

The first step is to select a diagnostic catheter with angiographic wire and navigate it over the aortic arch to the coronary artery. Obviously, the better you know the equipment and procedure, the faster you will be. Based on the patient information provided, you will choose a catheter. But if you choose one that is too large or too stiff, you risk complications, including an ostial dissection. Skill in this area can only be built through practice and experience. You need to position the tool so that it is not sensing dampening, which can be determined by observing the pressure wave trace on the fluoroscopic display. Once the catheter/wire is in place, you will pull the wire back from the tip so that contrast can flow, allowing good exposure for the cine.

ARTERIOGRAMS

We consistently teach our cardiovascular fellows the importance of obtaining the optimal angiographic views of the coronary circulation to perform coronary interventions most safely and effectively. This simulation system serves as a superb teaching tool in this regard. Due to patient anatomy, obtaining images in a real catheterization lab is not always easy or fast; the same is true when working with the CathLabVR™ system. Concepts including lesion foreshortening, vessel overlap, and device sizing—important for developing and refining operator technical skills—can be more easily realized using this system as a learning tool.

You will need to rotate and adjust the C-arm and zoom in. You need to work quickly. Next, run the selected cine and capture a good still of the lesion, one that shows its full length.

MEASURE, CALIBRATE, MEASURE

For the novice who may not be familiar with relative dimensions, the next step is to right click on the two sides of the catheter, its width being a known measurement. Press Calibrate and enter the catheter size, allowing the system to adjust its measurement scale. Press Clear to release the measurement function and begin again, this time addressing the

lesion itself (Figure 2). Measure the vessel's width at both ends of the lesion and the lesion length to choose an appropriate device.

Figure 2. Note the blue measurement line. Measure the vessel's width at both ends of the lesion and the lesion length in order to choose an appropriate device.

GUIDEWIRE DEPLOYMENT

Leaving the catheter in place, remove the diagnostic wire and navigate a thinner guidewire inside the coronary arteries, which will carry the therapeutic device(s). The guidewire must be stiff enough to push through a thrombus, but not so stiff as to dissect or perforate the arterial wall. Experienced interventionists rely on their honed sense of touch to feel their way through the vessel. If the wire seems too stiff or too weak, another is selected. However, in this case, almost any amount of trial and error is going to take too long. Good decisions, aided by simulated or real experiences, are required.

Interventional training teaches that "good judgment comes from experience, and experience comes from poor judgment." Judgment is costly when gained through real-life interventions; this is not so when gained from a simulator.

THE HEART STOPS

Suddenly, you have problems. The ECG and fluoroscopy show the heart has arrhythmias. On the CathLabVR™ system, administering adjunct therapy, such as defibrillation, is a matter of pressing a button and making onscreen selections. The therapy works, and the patient recovers, so you proceed.

BALLOON AND STENT

You have navigated the wire past the lesion and are ready to deploy a balloon or drug-eluting stent. How should you choose these devices? With practice, you know what to select; the CathLabVR™ system supplies device descriptions and suggested applications. In a real catheterization lab suite, an assistant would provide you with the nominal pressure needed for expansion. During simulation, this information is available from the system, as well.

You proceed with dilating the lesion (Figure 3). Hopefully, you are aware that placing a balloon or stent can potentially dislodge a thrombus that might embolize downstream. You are watching for the signs, the slow flow after injecting contrast into the coronary artery. You use the mouse to select adjunct therapy to dispense additional intracoronary medications (nitroglycerin, verapamil, or adenosine). Thankfully, the patient responds. You follow the CathLabVR™ system's postprocedure protocol, and feel good about your part in saving this virtual patient.

REAL-LIFE FAILURE RATE

Today, for this simulated patient with acute MI, good technique and swift procession through the correct steps led to success. If you had not been so prepared, the result would likely have been different because, to match real life scenarios, failure rate is programmed into the CathLabVR™ system. The simulated patient will not always live, but she and her real-life counterpart will have a better chance with a cardiac interventionist who has been through a simulated acute MI case. ■

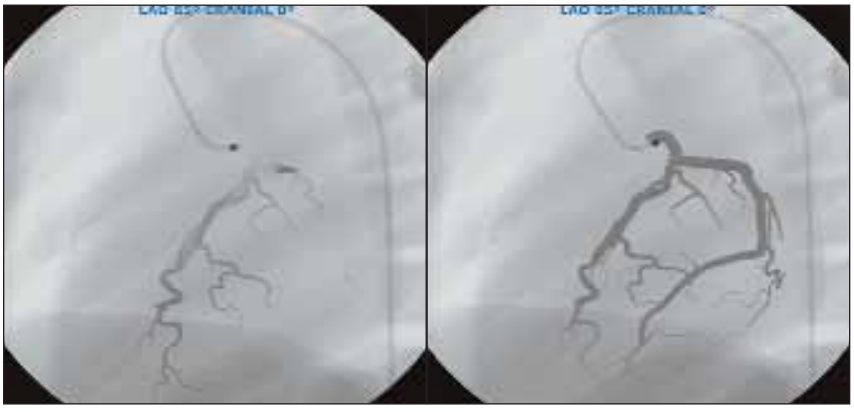

Figure 3. Fluoroscopic images showing pre- and post-stent placement on the CathLabVR™ system.

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