Implanted Ports, Computed Tomography, Power Injectors, and Catheter Rupture

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Patients with cancer often require computed tomography (CT) examinations to monitor the status of their disease. To enhance CT images, radiology personnel use power injectors to administer radiopaque contrast media at high pressures and controlled rates. If power injectors are used with implanted ports that are not designed to withstand pressures generated by the injectors, catheter ruptures can occur. Catheter rupture can lead to extravasation of vesicant contrast dye, catheter fragment emboli in the right atrium or pulmonary artery, and the need for port removal and replacement (U.S. Food and Drug Administration [FDA], 2006). Several vascular access manufacturers have recently developed implanted ports that are safe for power injection. For patients who may already have poor peripheral venous access, the ability to use their port to inject contrast media decreases discomfort from venipuncture and helps lower the risk for extravasation of vesicant contrast media.

Although power injectable ports have many benefits, serious adverse events can occur if safety processes are not developed and implemented. Oncology nurses can prevent catheter rupture by accurately identifying a port that is a power injectable port; using the correct power injectable, pressure-tested port needle to access the port; communicating with radiology personnel; and educating the patient about port safety issues.

Overview

In 2004, the FDA reported receiving more than 250 adverse event reports in which vascular access devices ruptured when power injectors were used to give contrast media as part of CT or magnetic resonance imaging studies (FDA, 2004). The events involved central venous catheters (including implanted ports), small-gauge peripheral catheters, extension tubings, and IV tubings. The catheter ruptures caused extravasation of vesicant contrast media, loss of catheter function, and the need for additional surgery to replace the line. In some cases, catheter rupture caused the catheter to fragment and embolize. The issue continued to occur despite warnings, resulting in additional FDA alerts (FDA, 2006).

Catheter Rupture and Fragment Embolization

Published case reports of implanted port catheter rupture have described catheter fragment embolization as being an incidental finding with few harmful effects (Liu, Tseng, Chen, Chern, & Chang, 2004). However, other authors have reported the occurrence of severe complications to be as high as 71% (Fisher & Ferreyro, 1978). In a study by Surov et al. (2008) examining 41 implanted port catheter fractures, most catheter fragments were found in the pulmonary artery, superior vena cava, and right atrium. The most common symptom of catheter embolization was port malfunction (39%). Of the patients in whom the catheter fragments were located in the right atrium, right ventricle, and pulmonary artery, 7.3% presented with cardiac symptoms. Complications included partial occlusion of the pulmonary artery, arrhythmias, pulmonary thromboembolism, pulmonary hypertension, and right ventricular failure. In 53.7% of cases, catheter embolism was found incidentally.

Factors causing pressure with resultant catheter rupture of the vascular access device or IV tubing included the flow rate of the power injector, catheter diameter and length, the viscosity of the contrast material, and obstruction to the flow of the contrast media (FDA, 2004). Obstructed flow in implanted ports can occur from fibrin, drug precipitates, catheter malposition, and the pinch-off syndrome. The pinch-off syndrome (also called costoclavicular pinching) refers to the process in which catheter compression between the clavicle and first rib over a prolonged period of time causes mechanical friction that weakens the catheter (Schulmeister, 2005). When the catheter is compressed, the risk for catheter rupture and fracture increases. The pinch-off syndrome has been reported to be the most common cause of catheter fracture (Surov et al., 2008).

The FDA’s (2006) recommendations to prevent catheter fracture from occurring include checking the label of each vascular access device for its maximum pressure and flow rate, knowing the pressure limit setting for the power injector and how to adjust it, and verifying that the pressure...
limit for the power injector does not exceed the maximum labeled pressure on the vascular access device.

**Power Injectable Implanted Ports**

Manufacturers have developed a variety of vascular access devices that can withstand the pressures generated by CT scan power injectors (5 mls/Power injection at 300 psi pressure limit setting). These devices include peripherally inserted central catheters, temporary external catheters, and implanted ports. Examples of power injectable ports include the PowerPORT™ Implanted Port (Bard Access Systems), the Smart Port™ (AngioDynamics, Inc), and the Port-A-Cath® II Power P.A.C. (Smiths Medical). To date, only single lumen power injectable ports are available in the United States. Power injectable ports come in different profiles and different materials (e.g., plastic, titanium). Some recent models have “CT” on the base of the port, which can be seen on x-rays or CT scans to help in port identification.

The PowerPORT Implanted Port is unique in that the port is a triangle shape and has three bumps located on the port septum (see Figure 1). The triangular shape and the bumps can be palpated and are used to assist in identification of the port as a PowerPORT Implanted Port prior to accessing the port with a noncoring needle. All other currently available power injectable ports are round in shape, similar to most nonpower injectable ports.

**Power Injectable Port Needles**

Power injectable ports are accessed and used according to the same procedures as nonpower injectable ports, with the only difference being the type of port needle used. Standard port needle tubings cannot withstand the pressures of the CT power injector; therefore, pressure-tested port needles must be used. Examples of power injectable port needles include the Gripper Plus® Power P.A.C. Safety Huber Needle (Smiths Medical) and the PowerLoc™ Safety Infusion Set (Bard Access Systems). Power injectable port needles are labeled and some are color coded. Instead of only stocking power injectable port needles, many institutions keep both power injectable port needles and nonpower injectable port needles. Placing a power injectable port needle into a non-power injectable port could be considered mislabeling of the port. Maximum flow rates for 19-gauge, 20-gauge, and 22-gauge power injectable needles are 5 ml/second, 5 ml/second, and 2 ml/second (respectively), and the maximum pressure setting for the Gripper Plus Power P.A.C. Safety Huber Needle and the PowerLoc Safety Infusion Set is 300 psi.

**Identifying Power Injectable Ports**

External power injectable venous access devices such as peripherally inserted central catheters can be identified easily by color coding and labeling on the catheter. However, implanted ports are challenging to identify because the port is underneath the skin. Implanted ports can remain in place for many years if needed and if no complications occur; therefore, hospitals and outpatient settings may have patients with power injectable and nonpower ports. Because of identification issues and the potential for implanted port catheter rupture, healthcare providers must develop a safe system to accurately identify ports at the time of access and immediately prior to power injection (see Figure 2).

The patient’s port type must be identified prior to access for the correct port needle to be used. If the patient’s port is not identified initially as a power injectable port and a standard port needle is used instead, the port will have to be reaccessed prior to CT power injection or the tubing could rupture. If the patient’s nonpower injectable port is accessed with a power injectable needle, the port could be misidentified as a power injectable port.

A literature search revealed no articles discussing power injectable ports, port identification, or safety recommendations. Manufacturers of power injectable ports have recommended that at least two methods be used to identify the port (AngioDynamics® Incorporated, 2008; Bard Access Systems, 2008; Smiths Medical, 2008). Ports can be labeled by identification cards, wristbands, and key chains supplied by port manufacturers; an operative note, which includes the type of port implanted and the location of the catheter; and palpation of the port. The triangular shape and three bumps on the septum of the PowerPORT Implanted Port offer another method for identification; however, palpation for shape should not be the only method used for port identification in patients with additional subcutaneous tissue or deeper ports.

The most critical step in port identification should occur in radiology prior to power injection. In addition to the methods for port identification mentioned previously, a CT scout scan prior to power injection will identify the shape of the port (e.g., triangular for the PowerPORT Implanted Port). For many newer power injectable ports, the letters “CT” will show up on the scan. The letters may be in different orientations (e.g., sideways, upside down) depending upon the orientation of the port when placed. The CT letters can also help identify a flipped port.

**Other Safety Considerations**

Prior to labeling the port needle tubing and prior to power injection, always confirm port patency by checking for a blood return, irrigating the port with normal saline and checking for infiltration, and ensuring that IV fluid can drip freely off the IV pump. If patency is questionable, follow the institution’s guides for assessing patency (e.g., dye studies) and clearing occluded catheters with alteplase (Camp-Sorrell, 2004). Do not proceed if patency and placement have not been confirmed.

To avoid the pinch-off syndrome, Bard Access Systems (2008) recommended inserting the catheter on a power injectable port into the internal jugular vein. If the practitioner chooses to insert the
catheter into the subclavian vein, Bard Access Systems further recommended placing the catheter lateral to the border of the first rib or at the junction of the axillary vein. If this subclavian approach is used, image guidance upon insertion and radiographic confirmation are highly recommended to ensure the catheter is not being pinched.

Prior to power injection, the contrast media to be injected should be warmed to body temperature to prevent catheter malfunction (Bard Access Systems, 2008). If possible, during power injection, patients should raise their arms vertically and place the palms of the hands on the face of the gantry (Bard Access Systems). This position allows the contrast to flow uninterrupted through the axillary and subclavian vein at the thoracic outlet.

**Patient Education**

Patients play a crucial role in preventing errors. Nurses should instruct patients to always carry and show their port identification cards and/or key chains to healthcare personnel before entry into the hospital system. Axel loc---computed tomography

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**Figure 2. Power Injectable Ports Process Flow**

*Note. Based on information from AngioDynamics® Incorporated, 2008; Bard Access Systems, 2008; Smiths Medical, 2008.*
professionals prior to port access or injection with contrast media. In addition, patients with power injectable ports should be taught that a special, power injectable needle should be used to access their port if CT power injection is planned.

**Conclusion**

Power injectable implanted ports allow healthcare professionals to use implanted ports for CT power injection, therefore decreasing the need for peripheral IVs and unnecessary needle sticks. However, the potential for catheter rupture and embolization does exist if nurses and other health professionals do not follow safety guidelines to identify power injectable ports, use the correct port needle, and educate patients regarding safety interventions.

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**References**


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