



## Diagnostic Cardiac Catheterization

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**D**iagnostic cardiac catheterization is the process of introducing, under local anesthesia, hollow plastic tubes 2 to 3 mm in diameter called catheters (Figure 1) into veins and/or arteries in the neck, leg, or arm, from which they are advanced to the right and/or left sides of the heart (Figure 2). Once the catheters are positioned in the various heart chambers or blood vessels, the pressure of the blood in various chambers of the heart can be measured, blood samples can be taken, and dye (radiographic contrast material) can be injected (a process called angiography) to allow x-ray visualization. Unlike bones, which are easily seen on x-ray, the heart and blood vessels cannot be visualized by x-ray unless they are filled with contrast dye.

The results of diagnostic cardiac catheterization often are extremely helpful in the evaluation of patients with suspected or known heart disease. For example, to determine if blockages in the arteries that supply the heart muscle (coronary artery disease) are present, the patient is positioned under an x-ray machine and contrast dye is injected through a catheter, the tip of which is positioned in the coronary artery of interest. The resulting images are recorded on photographic film or a digital medium, such as a computer or compact disk, for subsequent analysis and storage.

### Why Is Diagnostic Cardiac Catheterization Done?

Diagnostic cardiac catheterization can confirm or exclude the presence of a condition that is suspected from a patient's history, physical examination, and/or evaluation by such noninvasive methods as ECG, chest x-ray, echocardiogram, and exercise test. Diagnostic cardiac catheterization can be used to clarify a confusing or obscure situation in a patient whose clinical findings and noninvasive testing are unclear. Finally, it can confirm a suspected abnormality in the patient for whom heart surgery is planned and exclude associated abnormalities that might require the surgeon's attention.

### How Is Diagnostic Cardiac Catheterization Performed?

The patient, who is often mildly sedated, is positioned on a table under an x-ray machine. After the point of entry is anesthetized, catheter(s) are introduced into a vein or artery in the neck, leg, or arm, and then advanced while visualized by x-ray to the heart. The specific features of the procedure, including approach (ie, venous or arterial) and location (ie, from the arm, leg, or neck) are determined by the heart condition being evaluated, anatomic considerations unique to the patient,

and the preference and experience of the operator. For example, to obtain access to the right-sided heart chambers or blood vessels, catheterization is performed via a vein. Conversely, to gain access to the left-sided heart chambers or blood vessels, catheterization is performed via an artery.

Catheter introduction into an artery or vein can be performed percutaneously or via cutdown. With the percutaneous approach, the skin overlying an artery or vein is cleaned with sterile soap, anesthetic is injected into the surrounding skin and tissue, the blood vessel is punctured with a hollow needle, and a flexible metal wire is advanced through the needle into the blood vessel. After the needle is removed, a short hollow plastic tube approximately 6 inches in length (a sheath) is advanced over the wire into the vessel, after which the wire is removed. Once the sheath is securely positioned in the blood vessel, a catheter is advanced through it to the appropriate heart chamber using x-ray visualization. When the procedure is completed, the catheter and sheath are removed, local pressure is applied for 5 to 20 minutes to prevent bleeding, and the patient remains in the hospital on bed rest for 6 to 24 hours.

Alternatively, another way to perform a catheterization is via a cut-

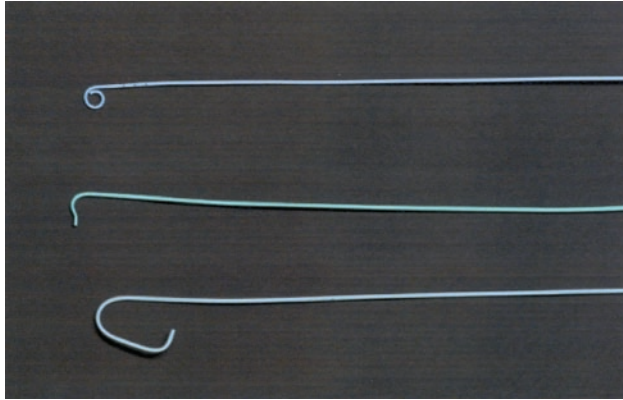
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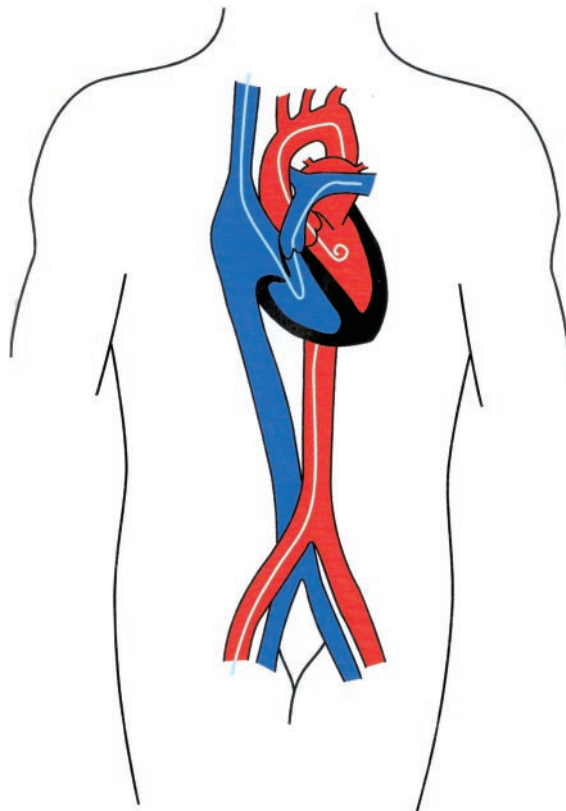
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**Figure 1.** Typical catheters used for pressure measurements and angiography. The catheters are approximately 100 to 110 cm (40 to 45 inches) in length and 2 mm (1/10 inches) in diameter.

down. With this technique, an area 1 to 2 cm above the elbow crease of the arm is cleaned with sterile soap and locally anesthetized. An incision 1 to 2 inches in length is made, and the artery

and/or vein is isolated with special instruments. A small incision is made in the blood vessel, through which a catheter is introduced and advanced to the heart with x-ray guidance. After



**Figure 2.** The arterial (red) and venous (blue) systems are depicted. In the venous system, a catheter (depicted in light blue) is seen coming from a vein in the neck and entering the right-sided heart chambers. In the arterial system, a catheter (also depicted in light blue) is seen coming from an artery in the leg and entering the left-sided heart chambers. This left-sided catheter is curled at its end, resembling a “pigtail;” hence, it is called a “pigtail catheter.”

the procedure is completed, the catheters are removed. The incision made in the artery for left heart catheterization is sutured, or the vein used for right heart catheterization is tied off. The initial skin incision is then sutured.

### What Are the Risks and Complications?

Diagnostic cardiac catheterization is performed with minimal risk. Several minor complications can occur. Injury of the artery or vein in which the catheter is introduced occurs in 0.5% to 1.5% of patients; the incidence is similar with the arm and leg approach. Bruising with skin discoloration at the site of blood vessel puncture occurs in 1% to 5% of patients. Rarely, surgery on the blood vessel, blood transfusions, or an infection at the site of catheter entrance may occur. The latter is usually treated effectively with meticulous wound care and antibiotics. The injection of contrast dye causes transient nausea and vomiting in 3% to 15% of patients, itching or hives in 1% to 3%, and a life-threatening allergic reaction in approximately 0.2%. For individuals with abnormal kidney function, the administration of an excessive quantity of contrast dye may worsen kidney function. A major complication, such as death, heart attack, or stroke, during or within 24 hours of catheterization occurs in only 0.2% to 0.3% of patients. Death may be caused by perforation of the heart or surrounding vessels, an abnormal heart rhythm, a heart attack, or a severe allergic reaction to contrast dye.

### Conclusions

Diagnostic cardiac catheterization plays a pivotal role in the evaluation of patients with suspected or known heart disease. It is commonly used to assess the presence and severity of coronary artery disease, heart valve problems, heart muscle dysfunction, and congenital heart disease. In the hands of experienced cardiologists, it is performed with minimal risk.



**KNOWN OR SUSPECTED HEART CONDITIONS FOR WHICH  
DIAGNOSTIC CARDIAC CATHETERIZATION MAY  
BE PERFORMED**

- Coronary artery disease (including heart attack)
- Heart valve problems
- Decreased heart function
- Congenital heart disease
- Elevated pressures in the heart chambers and/or great vessels
- Abnormal cardiac output (volume of blood flowing through the heart)
- Heart muscle inflammation, infection, or rejection (in the transplanted heart), for which catheterization is performed to obtain small pieces of tissue for microscopic examination (biopsy)

**Additional Information**

HeartPoint. Cardiac catheterization. Available at: <http://www.heartpoint.com/cathtell.html>. Accessed April 4, 2003.

HeartSite.com. Cardiac cath 1/5. Available at: [http://www.heartsite.com/html/cardiac\\_cath.html](http://www.heartsite.com/html/cardiac_cath.html). Accessed April 4, 2003.

US National Library of Medicine and National Institutes of Health. MEDLINEplus medical encyclopedia: cardiac catheterization. Available at <http://www.nlm.nih.gov/medlineplus/ency/article/003419.htm>. Accessed April 4, 2003.