# 272 Diagnostic Cardiac Catheterization and Coronary Angiography

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Diagnostic cardiac catheterization and coronary angiography are considered the gold standard in the assessment of the anatomy and physiology of the heart and its associated vasculature. In 1929, Forssmann demonstrated the feasibility of cardiac catheterization in humans when he passed a urological catheter from a vein in his arm to his right atrium and documented the catheter's position in the heart by x-ray. In the 1940s, Cournand and Richards applied this technique to patients with cardiovascular disease to evaluate cardiac function. These three physicians were awarded the Nobel Prize in 1956. In 1958, Sones inadvertently performed the first selective coronary angiography when a catheter in the left ventricle slipped back across the aortic valve, engaged the right coronary artery, and power-injected 40 mL of contrast down the vessel. The resulting angiogram provided superb anatomic detail of the artery, and the patient suffered no adverse effects. Sones went on to develop selective coronary catheters, which were modified further by Judkins, who developed preformed catheters and allowed coronary artery angiography to gain widespread use as a diagnostic tool. In the United States, cardiac catheterization is the second most common operative procedure, with more than one million procedures performed annually.

## CARDIAC CATHETERIZATION

### INDICATIONS, RISKS, AND PREPROCEDURE MANAGEMENT

Cardiac catheterization and coronary angiography are indicated to evaluate the extent and severity of cardiac disease in symptomatic patients and to determine if medical, surgical, or catheter-based interventions are warranted (Table 272-1). They are also used to exclude severe disease in symptomatic patients with equivocal findings on noninvasive studies and in patients with chest-pain syndromes of unclear etiology for whom a definitive diagnosis is necessary for management. Cardiac catheterization is not mandatory prior to cardiac surgery in some younger patients who have congenital or valvular heart disease that is well defined by noninvasive imaging and who do not have symptoms or risk factors that suggest concomitant coronary artery disease.

The risks associated with elective cardiac catheterization are relatively low, with a reported risk of 0.05% for myocardial infarction, 0.07% for stroke, and 0.08–0.14% for death. These risks increase substantially if the catheterization is performed emergently, during acute myocardial infarction or in hemodynamically unstable patients.

**TABLE 272-1 INDICATIONS FOR CARDIAC CATHETERIZATION AND CORONARY ANGIOGRAPHY**

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| **Coronary Artery Disease** |
| **Asymptomatic or Symptomatic** |
| High risk for adverse outcome based on noninvasive testing |
| Sudden cardiac death |
| Sustained (>30 s) monomorphic ventricular tachycardia |
| Nonsustained (<30 s) polymorphic ventricular tachycardia |
| **Symptomatic** |
| Canadian Cardiology Society Class II, III, or IV stable angina on medical therapy |
| Acute coronary syndrome (unstable angina and non-ST-segment elevation myocardial infarction) |
| Chest-pain syndrome of unclear etiology and equivocal findings on noninvasive tests |
| **ST-Segment Elevation Acute Myocardial Infarction** |
| Reperfusion with primary percutaneous coronary intervention |
| Persistent or recurrent ischemia |
| Pulmonary edema and/or reduced ejection fraction |
| Cardiogenic shock or hemodynamic instability |
| Risk stratification or positive stress test after acute myocardial infarction |
| Mechanical complications—mitral regurgitation, ventricular septal defect |
| **Valvular Heart Disease** |
| Suspected severe valve disease in symptomatic patients—dyspnea, angina, heart failure, syncope |
| Infective endocarditis with need for cardiac surgery |
| Asymptomatic patients with aortic regurgitation and cardiac enlargement or ↓ ejection fraction |
| Prior to cardiac surgery in patients with suspected coronary artery disease |
| **Congestive Heart Failure** |
| New onset with angina or suspected undiagnosed coronary artery disease |
| New-onset cardiomyopathy of uncertain cause or suspected to be due to coronary artery disease |
| **Congenital Heart Disease** |
| Prior to surgical correction, when symptoms or noninvasive testing suggests coronary disease |
| Suspicion for congenital coronary anomalies |
| **Pericardial Disease** |
| Symptomatic patients with suspected cardiac tamponade or constrictive pericarditis |
| **Cardiac Transplantation** |
| Preoperative and postsurgical evaluation |
| **Other Conditions** |
| Hypertrophic cardiomyopathy with angina |
| Diseases of the aorta when knowledge of coronary artery involvement is necessary for management |

Additional risks of the procedure include tachy- or bradyarrhythmias that require countershock or pharmacologic therapy, acute renal failure leading to transient or permanent dialysis, vascular complications that necessitate surgical repair, and significant access-site bleeding. Of these risks, vascular access-site bleeding is the most common complication, occurring in 1.5–2.0% of patients, with major bleeding events associated with a worse short- and long-term outcome.

In patients who understand and accept the risks associated with cardiac catheterization, there are no absolute contraindications when the procedure is performed in anticipation of a life-saving intervention. Relative contraindications do, however, exist; these include decompensated congestive heart failure; acute renal failure; severe chronic renal insufficiency, unless dialysis is planned; bacteremia; acute stroke; active gastrointestinal bleeding; severe, uncorrected electrolyte abnormalities; a history of an anaphylactic/anaphylactoid reaction to iodinated contrast agents; and a history of allergy/bronchospasm to aspirin in patients for whom progression to a percutaneous coronary intervention is likely and aspirin desensitization has not been performed.