Positron emission tomography (PET) using $^{18}$F-fluorodeoxyglucose (FDG) has been used to evaluate cardiac glucose utilization in different cardiac diseases, including hypertrophic cardiomyopathy, acute ischemic syndromes (infarction and unstable angina), and chronic ischemic left ventricular (LV) dysfunction. Most studies have evaluated patients with ischemic cardiomyopathy with the aim of assessing myocardial viability. Currently, the only clinically accepted application of cardiac FDG imaging is the assessment of viability in this subset of patients. Using FDG imaging for the assessment of viability makes prediction of improvement of LV function, heart failure symptoms, and long-term prognosis after revascularization possible. In the 1980s, FDG imaging could only be performed with PET equipment, but with the introduction of 511 keV collimators in the 1990s, FDG imaging is now feasible with single photon emission computed tomography (SPECT). Particularly with the increasing demand and the relative unavailability of PET equipment, the development of high-energy SPECT imaging was welcomed in the field of nuclear cardiology. Finally, with the development of dual-head coincidence imaging, the resolution of gamma camera PET imaging further approaches that of full view PET imaging. This chapter describes different aspects of cardiac FDG imaging. Following a discussion of the clinical relevance of viability assessment and the details of data acquisition and analysis, the evidence supporting cardiac FDG imaging is summarized. In particular, the studies focusing on prediction of outcome after revascularization and long-term prognosis are highlighted.

Viability Assessment and Clinical Relevance

Heart failure is becoming the most comprehensive problem in clinical cardiology, in terms of affected patients. Approximately five million Americans have chronic heart failure, and 400,000 new cases are diagnosed each year. Based on pooled analysis of the 13 multicentered heart failure trials published over the past ten years in the New England Journal of Medicine, coronary artery disease was the underlying etiology in almost 70% of the 20,000 patients involved in these trials. The prognosis of patients with ischemic cardiomyopathy remains poor, despite recent progress in medical therapy. The treatment of choice is heart transplantation, but the number of donor hearts does not match the enormous demand. An alternative modality of treatment may be coronary revascularization. Following revascularization, the left ventricular function of some patients improves, and this improvement in LV function may translate to superior survival. However, not all patients improve in LV function postrevascularization; in a recent study, approximately 35% of the patients improved significantly (that is, improvement in (LVEF) 5% or more) in LV function postrevascularization. Revascularization procedures are
associated with a substantially higher risk in this category of patients. Therefore, a careful evaluation is mandatory for optimal patient management and risk stratification.

In order to explain the postoperative improvement in LV performance and prognosis, the concept of viability has been proposed. Patients with viable myocardium have been demonstrated to improve in LV function, heart failure symptoms, and prognosis following revascularization. Conversely, patients without viable myocardium do not benefit. Another study has shown that preoperative viability testing results in improved perioperative risk stratification. Finally, retrospective analyses have demonstrated that the presence of viable myocardium in patients with ischemic cardiomyopathy, who were treated medically, was associated with an extremely high event rate. The exact prevalence of viability among patients presenting with heart failure secondary to poor LV function in the presence of chronic coronary artery disease is currently not clear. Auerbach et al. evaluated 283 patients with ischemic cardiomyopathy with FDG PET and demonstrated that 156 (55%) had viable myocardium. Schinkel et al. evaluated 104 patients (all chronic coronary artery disease, LVEF <35%) with FDG SPECT and demonstrated viability in 54% of the patients (Figure 5.1). Although these data were obtained in tertiary referral centers (and may not be applicable to the community), it appears that a substantial percentage of patients with ischemic cardiomyopathy have viable myocardium. This does not necessarily mean that all of these patients are suitable candidates for revascularization; other factors, including comorbidity, quality of target vessels, and severe LV dilatation, also influence the decision whether revascularization should take place. Still, considering the enormous number of patients with ischemic cardiomyopathy and the lack of optimal treatment for these patients, preoperative viability testing will help to guide patient management.

Currently, a variety of techniques are available for the assessment of myocardial viability, including nuclear imaging and stress echocardiography. Cardiac FDG imaging is considered the most accurate technique for the assessment of viability.

Protocols

First, information on contractile function is needed, since assessment of viability is predominantly important in regions with akinesia or severe hypokinesia. This information is currently provided noninvasively by echocardiography, radionuclide ventriculography, or gated perfusion SPECT or invasively in the catheterization laboratory.

Second, information on perfusion is needed. With PET imaging, a variety of tracers have been used to assess perfusion, including $^{82}$Rb, $^{13}$NH$_3$, $^{11}$C-acetate, and $^{15}$O-water. Since the half-life of these PET perfusion tracers is too short for SPECT imaging, SPECT tracers are used to assess perfusion, that is, $^{201}$Tl and $^{99m}$Tc-labeled agents.

Third, when FDG uptake is evaluated, the patient’s metabolic conditions are extremely important in determining cardiac FDG uptake. The perfusion and FDG data can be acquired sequentially or simultaneously. With PET and gamma camera based dual-head coincidence imaging, only sequential acquisition is possible. With SPECT imaging, both sequential