Incremental prognostic value of $^{99m}$Tc-tetrofosmin myocardial SPECT after percutaneous coronary intervention

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Abstract

Objective Percutaneous transluminal coronary angioplasty is a well-established therapeutic method in selected patients with coronary artery disease. The aim of this study was to assess the incremental prognostic value of technetium-99m ($^{99m}$Tc)-tetrofosmin myocardial gated-single-photon emission computed tomography (SPECT) in asymptomatic patients after coronary artery stenting.

Methods A total of 246 consecutive patients (aged 55.5 ± 8.2 years, 182 men) participated in the study with a median follow-up of 9.5 years (interquartile range 5.8–10.5 years). All patients underwent exercise gated-SPECT myocardial imaging within 5–7 months. Myocardial scintigrams were performed using $^{99m}$Tc-tetrofosmin, and were evaluated calculating the summed stress score (SSS), summed rest score (SRS), and summed difference score (SDS) indexes. Cardiovascular death and non-fatal myocardial infarction were considered as hard cardiac events, and late revascularization (>3 months after myocardial SPECT) procedures as soft events. Receiver-operating characteristic (ROC) analysis was used to test the prognostic ability of SSS and SDS for cardiac events. Cox proportional hazards models were used to evaluate the incremental value of SPECT variables.

Results Cardiac death occurred in 12 (4.9%) patients and non-fatal myocardial infarction in 20 (8.1%) patients. In addition, 60 (24.4%) patients underwent a late revascularization procedure. Using ROC analysis the optimal cut-offs of SSS (AUC = 0.94; 95% CI 0.92–0.97) and SDS (AUC = 0.76; 95% CI 0.70–0.82) for the prediction of cardiac events were 10 and 1.7, respectively. Multiple Cox regression analyses revealed that SSS > 10 (HR = 24.2; 95% CI 7.44–78.79) and SDS > 1.7 (HR = 2.72; 95% CI 1.23–6.00) provided incremental prognostic value over clinical and exercise test data for the composite end points of any cardiac event.

Conclusions $^{99m}$Tc-tetrofosmin myocardial gated-SPECT, performed 6 months post-percutaneous coronary intervention (PCI), provides incremental prognostic information for the prediction of cardiac events in asymptomatic patients after PCI.

Keywords Incremental prognostic value · PCI · Myocardial SPECT · $^{99m}$Tc-tetrofosmin

Introduction

Percutaneous transluminal coronary angioplasty (PTCA) is a routine indispensable therapeutic method in selected patients with coronary artery disease (CAD). This method has been widely applied worldwide, despite the high restenosis rate of 20%–65% in patients without stenting [1–3]. More recently, the introduction of
intracoronary stenting has resulted in a dramatic decline in acute complications and also a significant reduction of the restenosis rate to an average of 20%–25% [4–8]. As a result, the use of and indications for percutaneous coronary interventions (PCIs) have greatly expanded [9].

Even though the restenosis rate has in fact been reduced by intracoronary stenting, it still remains the major drawback of PCI and also an important clinical problem. Many studies have documented the lack of reliability of chest pain as a criterion of restenosis, even as the diagnostic accuracy of exercise electrocardiography testing is also limited [10–12]. On the other hand, coronary angiography is considered as the “gold standard” for detecting restenosis, but its invasive character is a major drawback for its application to follow-up patient post-PCI.

Myocardial perfusion single-photon emission computed tomography (SPECT) has been useful for the assessment of CAD and the identification of critical stenoses before angioplasty, as well as the follow-up evaluation of patients after the intervention and the early detection of restenosis [10–17]. However, on the prognostic value of myocardial SPECT, limited data have been reported with the usual tracers (201Tl, 99mTc-MIBI) in patients after PCI, although there are currently scarce data to suggest the prognostic value of 99mTc-tetrofosmin myocardial SPECT in patients after PCI [18–26]. Therefore, the aim of this prospective study was to evaluate the incremental prognostic value of 99mTc-tetrofosmin myocardial gated-SPECT in patients without cardiac symptoms after coronary artery stenting, over clinical and exercise testing variables.

**Materials and methods**

**Population**

The study population consisted of 246 consecutive patients, who underwent a successful PCI combined with a stent implementation (routine stenting), between January 1996 and December 1999. This group consisted of 182 men and 64 women, ranging in age from 32 years to 77 years (mean age 55.5 ± 8.2 years). All patients reported angina before the intervention, but remained asymptomatic afterward. Angioplasty and stenting were performed according to standard guidelines [5, 8]. Coronary arteries were submitted to revascularization only in the presence of initial narrowing ≥70%. Angioplasty success was defined as the dilation of at least one stenosis ≥70% of the luminal diameter resulting in a residual stenosis of <30% in diameter (a gain of ≥40% with respect to pre-angioplasty values) and without major complications (death, myocardial infarction, or coronary artery bypass grafting). Vessel luminal stenoses ≥50%, demonstrated by coronary angiography were considered as hemodynamically significant. Patients were considered to have undergone incomplete revascularization if they had stenosis of ≥50% in any coronary artery not subjected to revascularization.

Eighty-four patients (34.1%) had a previous myocardial infarction. A total of 132 patients (53.7%) had single-vessel disease: 90 of the left anterior descending artery, 14 of the left circumflex artery, and 28 of the right coronary artery, and they had successful PCI of the stenosed vessel. Ninety-six patients (39%) had two-vessel disease: 61 underwent a PCI of both stenosed vessels and 35 had a successful PCI of one vessel. Eighteen patients (7.3%) had three-vessel disease: four of them had successful one-vessel revascularization, 10 had two-vessel intervention and the other four had three-vessel angioplasty (Table 1).

All patients underwent symptom-limited exercise testing combined with single-photon emission computed tomography (SPECT) myocardial perfusion imaging, using 99mTc-tetrofosmin, about 6 months (5–7 months) after PCI. The routine follow-up using myocardial scintigraphy formed the basis of the study.

Pregnant women were excluded, as well as patients whose myocardial perfusion imaging might have been affected by factors other than myocardial ischemia. We therefore excluded patients with left bundle branch block, cardiomyopathy, severe valvular disease, and also those with an implanted pacemaker. We also excluded patients who had undergone coronary artery bypass grafting (CABG), suffered a myocardial infarction within a month before PCI, with contraindication to or inability to perform treadmill testing or to achieve a satisfactory exercise level because of a noncardiac condition (peripheral vascular disease, sciatica, neuropathy, disability, etc.) and patients taking digoxin (owing to its prolonged effect). Moreover, medications that could possibly influence patient performance on exercise testing and the related variables, were temporarily withdrawn (for about five half-lives). β-blockers were discontinued gradually (within a week—depending on the medication and the dose), with complete discontinuation at least 48 h before and during the study. Calcium channel antagonists and nitrates were discontinued 48 h and 24 h before and during the study, respectively. Additionally, any patient whose medication had not been discontinued as described above was excluded. Finally, patients with either angina, myocardial infarction or coronary bypass between PCI and SPECT imaging, those who were lost to follow-up or died of a non-cardiac cause during