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ScienceDirect

Nuclear Science and Techniques 19 (2008) 32–38

NUCLEAR SCIENCE AND TECHNIQUES

Proportion of viable myocardium is more reliable than semi-quantitative score in predicting functional recovery: a pilot study of PET myocardial viability imaging

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Abstract PET myocardial viability imaging is the "gold standard" for the non-invasive assessment of myocardial viability. The research aims to find out the best methods of imaging interpretation in predicting the postoperative functional recovery. Twenty-one CAD patients with multi-vessel involvement were recruited. All patients underwent gated myocardial perfusion imaging(G-MPI) and FDG PET myocardial imaging within 2 weeks before coronary artery bypass grafting. The postoperative G-MPI was performed in all patients 3 months after the surgery. Out of the total 420 segments, 164 segments of ischemic myocardium were detected by preoperative G-MPI. Among them, 93 ischemic segments were identified as non-viable(difference score≥0) and the rest 71 segments were identified as viable(difference score<0). The proportion of viable segments (the ratio of viable segments versus ischemic segments) and summed difference score of metabolism to perfusion were calculated. The patients were further divided into 2 groups according to the proportion of viable myocardium: group I (the proportion≥50%, 12 cases) and group II (the proportion<50%, 9 cases) while another division was made according to SDS: group A (SDS≥0), group B (-5≤SDS<0) and group C (SDS<-5). The diagnostic accuracy of proportion of viable segments and SDS in predicting the post-revascularization improvement in the left ventricular ejection fraction by at least 5 or more ejection fraction units was 88.89% (8/9) and 55.56% (5/9) respectively. It is concluded that both approaches allow accurate evaluation of myocardial viability. Furthermore, the proportion of viable myocardium is more reliable in predicting the postoperative functional recovery.

Key words Myocardial viability, Deoxyglucose, PET, Coronary artery disease

CLC number R445.53

1 Introduction

Coronary artery bypass grafting(CABG) is widely recognized as one of the best forms in treating coronary artery disease (CAD) and its short-, medium-, and long-term results are well documented[1]. In patients with CAD and impaired left ventricular (LV) function, the differentiation between dysfunctional but still viable myocardium and irreversible necrotic tissue has important clinical implications[2–4]. It is now clear that in many patients LV dysfunction may be reversible following coronary revascularization[5]. Therefore, the distinction of LV dysfunction caused by fibrosis from that arising from viable but dysfunctional myocardium is a relevant diagnostic issue and has important implications for patients with a low ejection fraction, in whom heart failure may be attributed to hibernation or stunning (or both) rather than to necrosis[6].

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Received date: 2007-12-04

Single-photon emission computed tomography (SPECT) with ^{201}Tl or ^{99}Tc^{m}-labelled agents has been widely used in clinical practice to detect myocardial viability[7–9]. However, combined with myocardial perfusion imaging, positron emission tomography (PET) metabolic imaging with ^{18}F-fluorodeoxyglucose (^{18}F-FDG) has been recognized as the non-invasive gold standard for differentiating viable from non-viable myocardium[10–12]. Nevertheless few articles focusing on the comparison of different image interpretation methods have been issued. In our research, we aimed to evaluate the clinical role of PET myocardial viability imaging in identifying the potential benefits from CABG and compare the semi-quantitative score system with proportion of viable segments in predicting the functional recovery.

2 Materials and methods

2.1 Patients population

Twenty-one consecutive patients with multi-vessel involved coronary artery disease (16 males and 5 females, mean age=65.38±8.48 years) were prospectively recruited from the department of Cardiac/Thoracic Surgery. The coronary artery stenosis or occlusion of all patients were identified by coronary angiography. All patients were proved to have at least 2 main coronary branches involvement and the major stenosis was greater than 80% (15 cases with LAD, RCA and LCX involvement, 4 cases with LAD and RCA involvement, 2 cases with LAD and LCX involvement). Gated myocardial perfusion imaging (G-MPI) using ^{99}Tc^{m}-sestamibi and PET myocardial metabolic imaging using ^{18}F-FDG were performed in all patients within 2 weeks before surgery to identify the viability of ischemic myocardium. All patients underwent off pump coronary artery bypass (OPCAB) while 4 cases underwent ventricular aneurysm dissection simultaneously. G-MPI was performed as the major follow-up work-up in the 3rd month after surgery to check out the improvement of cardiac function and myocardial perfusion.

2.2 G-MPI data acquisition

Patients received an intravenous injection of ^{99}Tc^{m}-sestamibi (925MBq) and were told to take a cup of milk 30-45 minutes afterward to minimize overlap of hepatobiliary with myocardial activity. Acquisition began 30-45 minutes after the ingestion of milk and a dual-head gamma camera system (ADAC Vertex V60) was employed for scan. The camera system was equipped with VXGP collimator. The energy window was centered at 140 keV photon peak of technetium-99m sestamibi with a 20% window. Data acquisition(step mode, circular orbit) was done in supine position over 180° (45°RAO to 45°LPO). A total number of 64 projections, of which the scan time was 40 seconds for each, were collected. Eight frames/cycle were acquired using an R wave-triggered electrocardiogram gated system and the allowable change of heart rate was 20%. Data were stored in a 64×64, 16bit matrix. A cine review was applied prior to reconstruction to verify the absence of patient motion.

2.3 G-MPI data reconstruction and interpretation

The raw data were reconstructed by filtered back projection using a Butterworth filter (cut off frequency at 0.5, order at 5). Attenuation correction was not applied. Further reconstruction and reorientation yielded standard short axis, vertical long axis and horizontal long axis planes.

The images were interpreted by two experienced nuclear physicians, who were blinded to any results of other work-ups. According to the interpretation guidelines for myocardial perfusion imaging issued by American Society of Nuclear Cardiology (ASNC), a 20-segment model and 5-point scoring system were employed in the study to evaluate the location, extent and severity of myocardial ischemia[13]. The severity of abnormal tracer uptake was graded as follows: 0, normal; 1, mildly reduced; 2, moderately reduced; 3, severely reduced and 4, absent. Resting score (RS) and summed resting score (SRS) were calculated. RS presented the tracer uptake grade of every single segment according to the criteria above. SRS=the sum of RS of all segments. Other parameters of left