ELSEVIER

Clinical Imaging 31 (2007) 228–233

CLINICAL IMAGING

Single- vs. dual-head SPECT for detection of myocardial ischemia and viability in a large study population

Jan Bucerius*, Alexius Y. Joe, Ina Lindstaedt, Agnieszka Manka-Waluch, Karl Reichmann, Samer Ezziddin, Holger Palmedo, Hans-Jürgen Biersack

Department of Nuclear Medicine, University of Bonn, Bonn, Germany

Received 10 August 2006; accepted 10 February 2007

Abstract

Background: As single-head data acquisition for thallium-201 myocardial SPECT is a frequently used method mainly in the outpatient medical care as well as in smaller hospitals, comparison to dual-head data collection is a still discussed issue mainly with regard to quality control and -assurance.

Methods: A total of 1334 patients undergoing thallium-201 myocardial SPECT for diagnosis of myocardial ischemia and/or viability have been retrospectively analyzed. In 554 patients, a single-head gamma camera (360° rotation) has been applied, whereas a dual-head gamma camera (180° rotation) has been used in 780 patients. Four hundred twenty-six patients received both myocardial SPECT as well as coronary angiography. The diagnostic value of both applied acquisition techniques has been analyzed.

Results: Regarding myocardial viability, positive predictive value for the diagnosis of myocardial scar tissue was significantly higher for dual-head- as compared to single-head acquisition. Among the 426 patients undergoing diagnosis of myocardial ischemia, significant differences have only been found with regard to specificity being higher in the single-head acquisition. Diagnosis of myocardial ischemia related to a distinct myocardial perfusion region showed a significantly higher sensitivity of dual-head acquisition for the left anterior descending perfusion area, whereas specificity was significantly higher for single-head acquisition.

Conclusions: Our results indicate a beneficial effect of dual-head data collection with regard to sensitivity of the diagnosis of myocardial ischemia. In contrast, single-head data acquisition was superior with regard to specificity. However, it is justified to preferably apply dual-head data collection in clinical routine due to the shorter acquisition time leading to an evident time benefit of this acquisition technique.

Keywords: Myocardial SPECT; Single-head; Dual-head; Myocardial ischemia; Myocardial viability

1. Introduction

For many years, thallium-201 myocardial single photon emission computed tomography (SPECT) has been widely used in clinical routine for the diagnosis of coronary artery disease, i.e., myocardial ischemia, as well as for detection of myocardial viability [1–6].

However, the camera systems, study protocols, and data acquisition have varied considerably in different thallium-201 studies during the last years. In particular, the choice of data sampling using single- and dual-head data acquisition has been a frequently discussed issue as tomographic myocardial perfusion imaging in a clinical setting has the conflicting needs of obtaining high-quality images in a short acquisition time [7,8]. Although nowadays dual-head data collection is tendentially preferred, single-head data acquisition is still frequently used mainly in outpatient medical care as well as in smaller nonuniversity hospitals.

Several studies have been undertaken to investigate the relative advantages of 180° vs. 360° acquisitions, with most centers adopting a 180° protocol [8–14]. The advantages of 180° angular sampling in myocardial SPECT are shorter acquisition time if the same time per frame is used, better defect contrast, and, in some cases, better spatial resolution [11,14]. However, it is not possible to average opposite views potentially leading to higher geometric distortion than 360° angular acquisition protocols [14]. As such, the signals from the opposite 180° can be markedly attenuated and

* Corresponding author. Department of Nuclear Medicine, University of Bonn, Sigmund-Freud-Str. 25, 53105 Bonn, Germany. Tel.: +49 228 287 5181; fax: +49 228 287 9096.

E-mail address: jan.bucerius@ukb.uni-bonn.de (J. Bucerius).

0899-7071/07$ – see front matter © 2007 Elsevier Inc. All rights reserved.
doi:10.1016/j.clinimag.2007.02.025

Table 1
Patient characteristics

	Total	Single	Dual	*P* value
N	1334	554	780	
Age	59±10.6	57±10.1	61±10.8	<.0001
Gender				
Male (%)	925 (69.3)	401 (72.4)	524 (67.2)	.47
Female (%)	409 (30.7)	153 (27.6)	256 (32.8)	
HR bpm (achieved)	132±23.5	132±22.6	131±23.5	
HR bpm (calculated)	137	139	135	
% of calculated HR	96.4	95.0	97.0	
Angiography[a]				
n	605	164	441	
Stenosis LAD	256	71	185	.782
Stenosis RCA	217	55	162	.505
Stenosis RCX	165	50	115	.305

[a] Angiography performed in 605 patients of 1334 patients.

could degrade the image [9]. Furthermore, a greater incidence of image artifacts has been reported for the 180° data sampling [11,14]. Above that, few data are published regarding the diagnostic value of 180° as compared to 360° data sampling of thallium-201 SPECT in the assessment of myocardial viability [7]. However, only a few data have been published focusing on the comparison of single- vs. dual-head data collection.

Therefore, in the context of quality control and assurance, this study was designed to assess the diagnostic value of single- (using a 360° rotation) vs. dual-head myocardial (with 180° rotation) SPECT for the diagnosis of both myocardial ischemia as well as viability in a large study population.

2. Methods and patients

2.1. Study population

A total of 1334 patients were included in this retrospective analysis. Thallium-201 myocardial SPECT was performed between 1990 and 2000. A single-head gamma camera (Elscint Apex, Elscint, Haifa, Israel; $n=554$) was used between January 1990 and May 1995, and a dual-head gamma camera (ADAC Vertex, ADAC Laboratories, Milpitas, CA, USA; $n=780$) between June 1995 and December 2000. In the current study, for dual-head acquisition a 180° rotation was used, whereas for single-head collection a 360° rotation was applied (Table 1).

In 1293 patients, stress imaging was performed. Of those, 1236 underwent bicycle stress testing, whereas 57 patients had been pharmacologically stressed exclusively with dipyridamole (Persantin, Boehringer Ingelheim Austria GmbH, Vienna, Austria). In 186 patients, an additional rest imaging was performed 1 day after the stress–rest imaging. Forty-one patients underwent only rest imaging. Two hundred seventy-seven patients had a history of myocardial infarction which has been diagnostically proven by significant alterations in the electrocardiogram, in wall motion abnormalities, e.g., akinesis or hypokinesis of distinct myocardial regions, and/or significantly reduced left ventricular ejection fraction in the echocardiography or by a positive course of cardiac enzymes, e.g., troponine I and T as well as myocardial-specific creatine kinase. Mean age of these 1334 patients was 59±10.6 years (Table 1).

Six hundred five patients of the total study population received both myocardial SPECT as well as coronary angiography (CA; Table 1). Of those, 165 received myocardial revascularization with coronary artery bypass grafting (CABG) and/or percutaneous trans coronary angioplasty (PTCA) either with or without coronary stenting. As the time interval between myocardial SPECT and coronary intervention could not be retrospectively evaluated, those patients have been excluded from comparison between SPECT and CA. As additionally 14 patients received only rest imaging for assessment of myocardial viability, at least a total of 426 patients (age, 60.1±9.82 years) underwent stress–rest imaging and could be included for comparison between SPECT and CA. One hundred thirty-eight patients have been examined with the single-head gamma camera, and 288 patients underwent myocardial SPECT with the dual-head gamma camera. Four hundred six patients underwent bicycle stress testing; the remaining 20 patients received dipyridamole for pharmacological stressing. An additional rest imaging for assessment of myocardial viability has been performed in 83 patients the day after the stress–rest imaging.

Patients with angiographically proven significant (50%) stenosis of at least one coronary artery suffered from single-vessel disease in 103 cases, from two-vessel disease in 79 cases, and from three-vessel disease in 88 cases. In 28 patients, a significant coronary stenosis has been confirmed without adequate information of the vessels involved. In 128 patients, no significant coronary stenosis could be shown. History of myocardial infarction was present in 136 of the 426 patients evaluated.

2.2. Thallium-201 scintigraphy

Thallium-201 myocardial SPECT has been performed according to the standard protocol of the Department of

Table 2
Data acquisition single- vs. dual-head SPECT

	Single (Elscint Apex)	Dual (ADAC Vertex)
Energy window (%)	141±10	141±10
Total rotation angle	360	180
Gantry rotation	180	90
Collimator	LEHR	VXHR
FOV (cm)	38	38
Acquisition matrix	64×64	64×64
Pixel size (mm)	5.9	5.9
Total number of projections	64	32
Acquisition time (seconds/projection)	40	40
Tomographic reconstruction	Filtered back-projection	Filtered back-projection
Cutoff frequency/order	0.50/10	0.50/10
Filtering in *z*-direction	ϕ	Analytic

LEHR indicates low energy high resolution; VXHR, vertex high resolution; FOV, field of view.