

Attenuation corrected stress myocardial SPECT: possibility of reduction in number of rest investigation

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Abstract

BACKGROUND: Attenuation-corrected (AC) imaging frequently shows normal stress myocardial perfusion while non-corrected (NC) imaging shows hypoperfusion. The aim of the work was to assess whether it is necessary to continue with resting examination in this situation.

MATERIAL AND METHODS: 121 consecutive patients had positive finding at AC and/or NC sestamibi stress myocardial imaging using E.CAM Profile system and resting examination was carried out. AC stress imaging was normal while NC imaging showed hypoperfusion in 29 cases. In one case this finding was reversed. In this group of 30 patients with AC/NC stress discrepancies, resting examination has not revealed any additional information in 28 cases.

RESULTS: In 2 cases NC imaging, in contrast to AC, showed stress ischaemia. In one of these 2 cases coronarography was carried out with negative result. In the other case patient refused coronarography.

CONCLUSIONS: The resting examination did not bring any benefits in 29–30 cases out of 30 (96.7 to 100.0%) patients with AC/NC stress discrepancies. If the results of this study are con-

sidered accordingly, in our group approximately one fourth of the resting examinations (29 to 30 out of 121) could be saved.

Key words: attenuation correction, single-photon emission tomography, myocardial perfusion, sestamibi, cost-effectiveness

Introduction

Transmission attenuation correction (TAC) [1] of single-photon emission tomography is still developing and its possibilities may not have been completely exploited [2]. There are clinical studies which demonstrate the benefits of TAC [3] and also negative results [4]. These facts support the suspicion that there are significant differences among the systems offered. Therefore the decisions on the clinical utilisation of TAC should be very careful.

Attenuation-corrected (AC) imaging by Profile system frequently shows normal stress myocardial perfusion while non-corrected (NC) imaging shows hypoperfusion. It is unclear whether it is necessary to continue with resting examination in this situation or to leave it and save money and radiation burden. The aim of this work was to carry out a retrospective evaluation of this situation.

Material and methods

Group of patients

Between January and November 2000 suspected ischaemia was found on AC and/or NC stress imaging in 128 consecutive patients, and therefore the rest examination was carried out. In the process of retrospective evaluation, 5 patients were excluded due to the disturbing activity in the splanchnic region. Image data of 2 patients were not restorable. The group of 121 patients (53 females and 68 males) at the ages of 40 to 80 years (mean = 58 years) is further considered. The weight of the patients ranged between 50 and 118 kg (mean = 82 kg). All patients were referred to the examination for medical and not research reasons. Neither

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the approval of the ethical committee nor the informed consent of the patients was requested for the retrospective evaluation of the data from routine operation, because the data are presented anonymously.

Instrumentation

The patient attenuation maps (μ maps) were measured by Profile Attenuation Correction System on a dual-detector E.CAM system (Siemens). The Profile system consists of 2 wings containing 14 pairs of transmission line sources (^{153}Gd). The layout of sources is from the strongest ones (740 MBq) located centrally to the peripheral weakest ones (33 MBq).

Acquisition and reconstruction

Data were acquired into 4 energy windows ($^{99\text{m}}\text{Tc}$ window at 140 keV, ^{153}Gd window at 100 keV and their scatter) 30 minutes after the exercise or 60 minutes after the resting administration of 7.5 MBq/kg of $^{99\text{m}}\text{Tc}$ -sestamibi. Non-circular orbit 180° scan was used for 2×32 projections, each 25 s or 29 s according to stress or rest condition. NC slices and map of distribution of attenuation coefficients were reconstructed by filtered back projection. AC slices were reconstructed in 10 iterations by standard software ICON 8.1.

Method of evaluation

Standard slices of the left ventricle were retrospectively re-evaluated visually by an experienced physician, because no database of patients with low probability of coronary artery disease, scanned under similar conditions, was available. The myocardium was divided into 17 segments (Fig. 1). In each segment the perfusion was visually evaluated as normal or reduced using both AC and NC imaging. Ambiguous findings were evaluated as reduced perfusion.

Results

In 91 patients hypoperfusion was found during stress in one or more segments, both with AC and NC imaging. A more detailed analysis of this part of the group of patients is beyond the scope of this communication, because it would not enable a reduction in the number of resting examinations.

Stress AC imaging was normal in 29 patients, while hypoperfusion was found in at least one of the segments with NC imaging. The distribution of NC hypoperfused segments for males and females is presented in Figure 1. At rest the AC and NC finding did not change in 27 patients, which means that stress ischaemia was not demonstrated. One female was normal on AC finding both at rest and stress, but NC showed stress-induced ischaemia in the antero-septal segment. Subsequent coronarography was completely normal. A similar situation was detected in one male in the basal part of the inferior wall. The patient refused coronarography and remains under monitoring. Conversely, normal stress on NC finding was present in one male, while AC imaging revealed hypoperfusion of the anterior wall. At rest the AC and NC findings did not change.

Additional resting examination added no information in 28 out of 30 cases. In the remaining two patients NC in contrast to AC

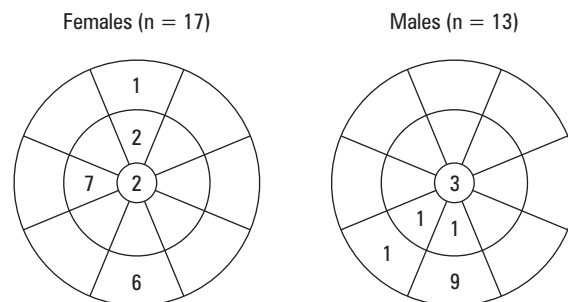


Figure 1. Layout of 17 segments of left ventricle. Numbers represent number of NC hypoperfused segments in 29 patients with normal stress AC images. Females are on the left, males on the right.

showed stress-induced ischaemia. In one case this was a false positive finding, in the other one there is no final conclusion. This means that the resting examination did not bring any benefits in 29–30 cases out of 30 (96.7 to 100.0%). If the results of this study are considered accordingly, in our group approximately one fourth of the resting examinations (29 to 30 out of 121) could be saved.

Discussion

No benefit of rest study could be assumed when insufficient stress is applied. In the subgroup of 30 patients the stress led to heart rate on average 88% of maximal aerobic capacity (MAC).

The TAC system, which was used for this purpose, in combination with constant transmission scanning time allowed a high-quality μ -map (Fig. 2) to be obtained in most cases across the large range of patients' weights. Nevertheless the acquisition time had to be varied according to patient mass, to equalise quality of transmission scans.

The Profile TAC system can be easily extended to the working position and does not prolong the period of setting the camera. The quality control consists in taking blank scans after the change of sources or during the regular monthly check of the whole camera. The fixed arrangement of the sources is beneficial, because there is no axial movement during the examination. Simultaneous acquisition of both emission and transmission data does not prolong the period required to carry out the examination. The layout of sources with different activity minimises the costs of operation: every 6 months the weakest sources are taken out and the remaining ones are moved to the neighbouring peripheral position. New sources are installed centrally. Layout of sources compensates the density of photon flow after the passage through both the centre of the patient's body and its surface. In consequence the system ensures the high quality of the resulting μ -map even in obese patients immediately prior to the change. Shielded sources are opened during the acquisition only. Additional radiation doses of the operators is therefore close to zero. The dose for patients is also negligible. The manufacturer presents the dose around $1 \mu\text{Sv}$, which corresponds very well with the result of $1.6 \mu\text{Sv}$ obtained from our own measurement, using FH 40G meter (ESM Erlangen).

The NC imaging in males showed the reduced activity most frequently in the inferior segment, less frequently in inferoseptal

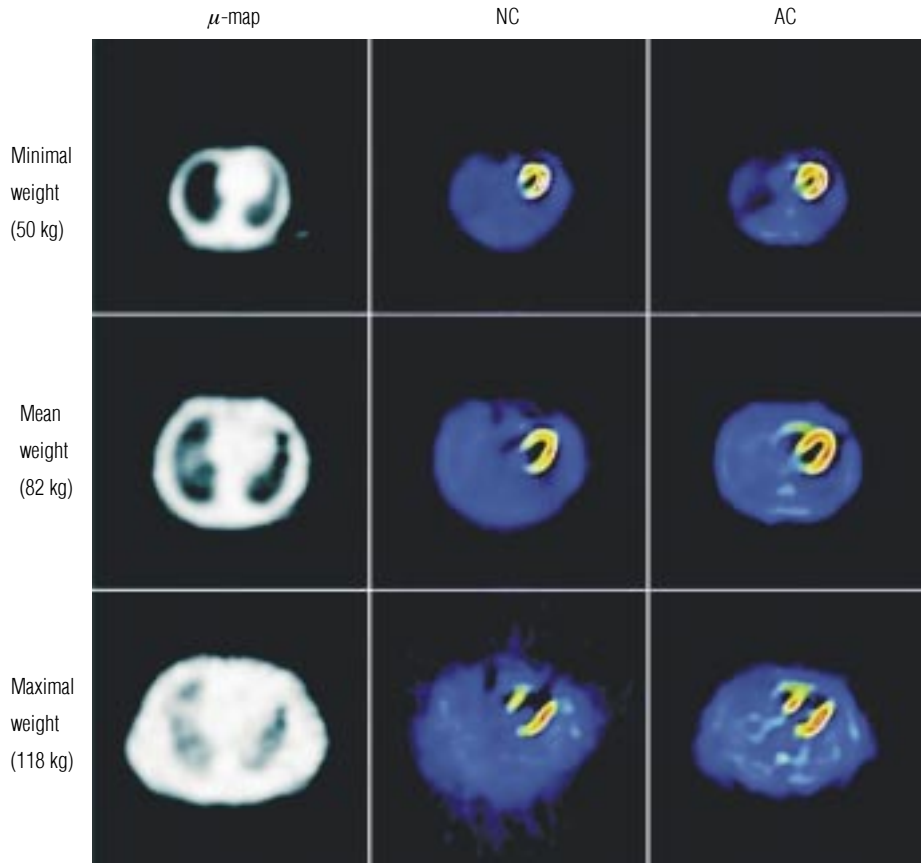


Figure 2. Transaxial slices. Horizontal direction: μ -map on the left, NC in the middle, AC on the right. Vertical direction: values for the patient with lowest weight (50 kg) on the top, for the mean weight (82 kg) in the middle, for the heaviest patient (119 kg) on the bottom.

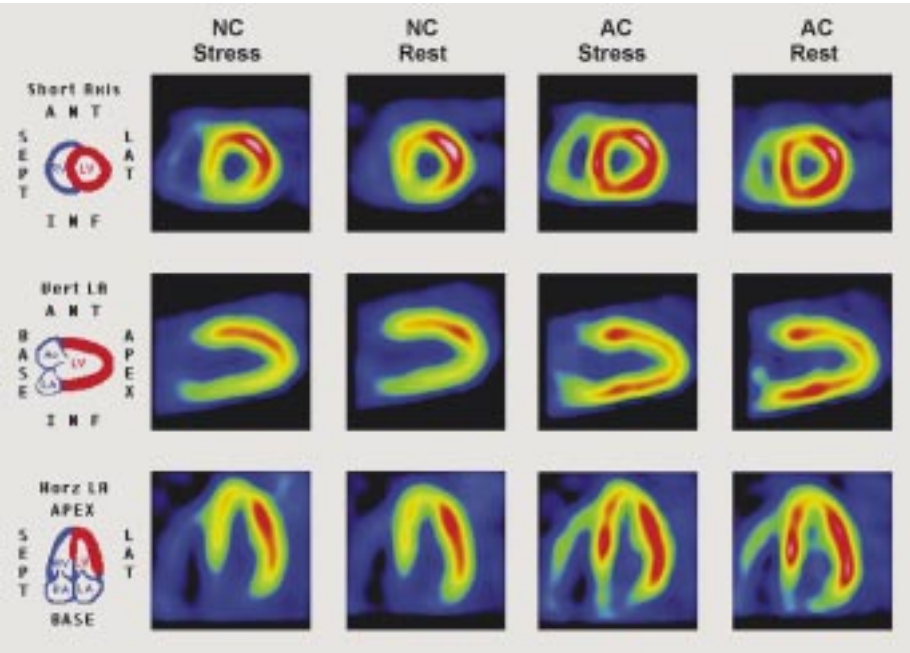


Figure 3. Example of hypoperfusion of the inferior wall with NC imaging in the male at rest and after stress (92% MAC). Normal perfusion distribution with AC imaging.

segment and in the apex of the left ventricle. In females the NC imaging showed reduced accumulation most frequently in antero-septal and inferior segment and less frequently in anterior segment and in the apex. The AC imaging allowed a much more homogeneous depiction of myocardial perfusion (Fig. 3), in concordance with [5].

Conclusions

The resting examination did not bring any benefits in 29–30 cases out of 30 (96.7 to 100.0%) patients with AC/NC stress discrepancies. If the results of this study are considered accordingly, in our group approximately one fourth of the resting examinations (29 to 30 out of 121) could be saved. This result is encouraging for further use of the Profile TAC system in routine practice. Nevertheless if this method is to become a standard in nuclear cardiology, a multi-centre comparison of the results of TAC and coronarography should be carried out in larger groups.

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