Use of Quantification in Cardiac Reporting: How does it change the Clinical Result?

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Abstract

Many gamma camera systems are now sold with cardiac quantification packages. These are said to increase the accuracy of reporting. However the use of such quantification packages may change the clinical report as read from the tomographic slices. The aim of this study was to quantify the differences between qualitative visual reporting and quantification. The stress and rest myocardial perfusion studies were quantitatively reported in 37 patients comprising 333 segments of the heart (9 segments/patient). A defect was defined by a reduction in activity of >50% in each of the segments. For the tomographic qualitative reporting the data was reconstructed using iterative reconstruction with a Wiener smoothing filter. Quantification used an Emory bull's eye system with gender and age matched normal controls. Number of abnormal segments noted by qualitative reading of data were 119 at stress and 79 at rest. For the bull's eye plot 98 abnormal segments were seen at stress and 76 at rest. Thirty-three segments (10%) were abnormal on the qualitative reading of data alone and 7 (2%) were abnormal on bull's eye alone. Of the 55 segments reported as ischaemic qualitative reading of data, 26 (48%) were normal on bull's eye, 13 of these in the right coronary artery (RCA) territory segments. Of the 67 segments reported on the qualitative reading of data as infarct, 10 (13%) were normal on bull's eye, 7 of these in the territory of the RCA segments. There are significant differences in the results of reporting scans using a bull's eye plot especially in identifying inferior wall ischaemia. Therefore before using such a quantification method a full assessment of the accuracy of each method should be performed.

Key words: myocardial perfusion scintigraphy, visual reporting, bull's eye quantification

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Introduction

Nuclear Medicine techniques in cardiology are inherently quantitative, but in most departments the scans are read in a qualitative way, which may lead to a reader-based bias. Considerable efforts have been directed toward improving imaging agents and imaging equipment, relatively little attention has been given to factors that optimise image interpretation (1). The assessment of cardiac patients could be enhanced by quantitative description of the specific functional parameters evaluated by scintigraphy. Presently, there is no method, clinically available, for obtaining absolute quantitative values from the SPECT data (2). Therefore data based methods of quantification are more widely used and most gamma camera systems are now sold with attractive cardiac quantification packages. These are said to increase the accuracy of reporting. Many of these computer methods were developed either at Cedar-Sinai Medical Centre or Emory University (2) both based in USA.

The concept of data based quantification involves image processing to enhance the image, image analysis to extract values for measurements for use in determining normality versus abnormality and finally comparison of extracted values with a database of results from normal patients to quantify the degree of abnormality.

The Cedars-Sinai method of quantitative approach to SPECT is based on sampling of the patients short and vertical long axis myocardial tomograms using maximum count circumferential profiles and comparing these patients' profiles to profiles derived from a database of normal patients (2).Quantitative methods that involve comparison to a normal database require strict adherence to specific acquisition and processing protocols (2).

A bull's eye method of quantification was implemented at Emory University. In this method, only the short axis slices are used for quantification. The short-axis slices to be quantified are selected by an operator following a strict protocol. Using the long-axis slice with the largest cavity length, the operator selects the short axis cuts for the quantification to extend from the base of the left ventricle to the apical cap (2). However one is not very sure if such methods change the way we report or read myocardial perfusion scintigraphy. The aim of this study was to determine the differences between qualitative visual reporting and the Emory bull's eye quantification.

Materials and Method

In our study 37 patients (28 males and 9 females) with age ranging from 48-70 yrears were included. All the patients underwent pharmacological stress test using adenosine or dobutamine (in patients with asthma) using standard protocols. The patients were injected with Tc-99m tetrofosmin (Myoview- Nycomed-Amersham) using a dose of 250 MBq for stress and 750 MBq for rest imaging. The patients were imaged with a one-day stress rest protocol. The time interval between injection and imaging was a minimum of 45 minutes and a fatty meal was given to all the patients.

The patients were scanned on the Double and Triple head Prism 2000XP gamma camera (Picker International, Inc. Cleveland Ohio, USA), interfaced to Odyssey VP computer.

The acquisition protocol consists of obtaining 32 projections for 40 second each over the 180-degree arc. The tomographic slice images were reconstructed using the iterative reconstruction with a Wiener smoothing filter.

The qualitative assessment of stress and rest myocardial perfusion scintigraphy was conducted in all patients. The processed stress and rest images were visually analysed by the Nuclear Medicine experts. The myocardium was divided into 9 segments per patients (Figure 1) so a total of 333 segments of the heart (9 segments/patient) were analysed .A defect was defined by a reduction in activity of >50% in a segment. It was described as ischaemic if there was a return of at least 25% of this activity in that segment

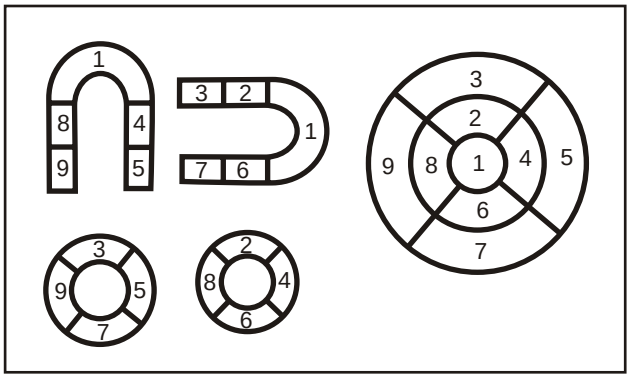


Figure 1. Diagram of the 9 segments used for reporting

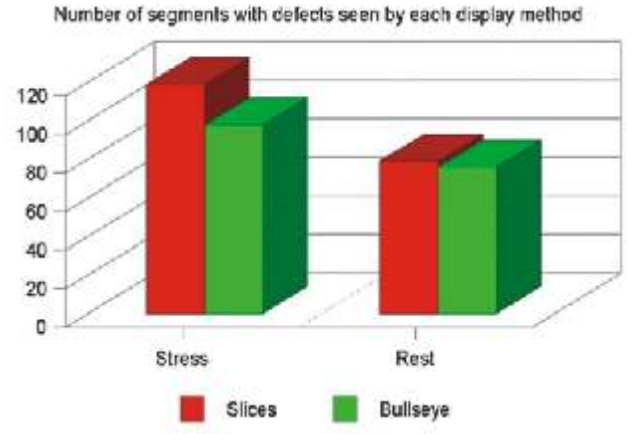
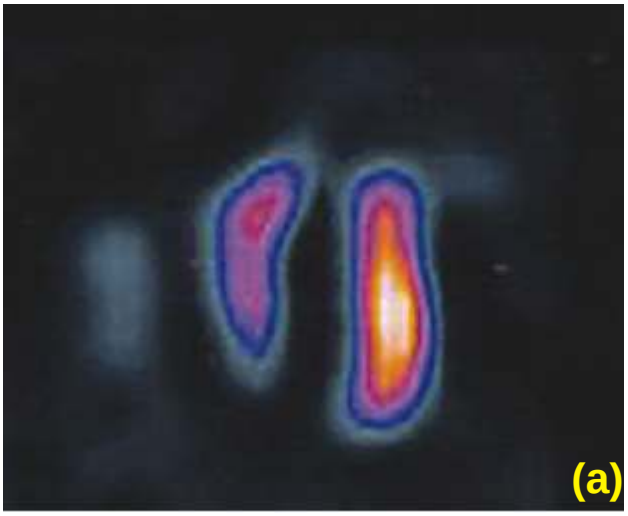
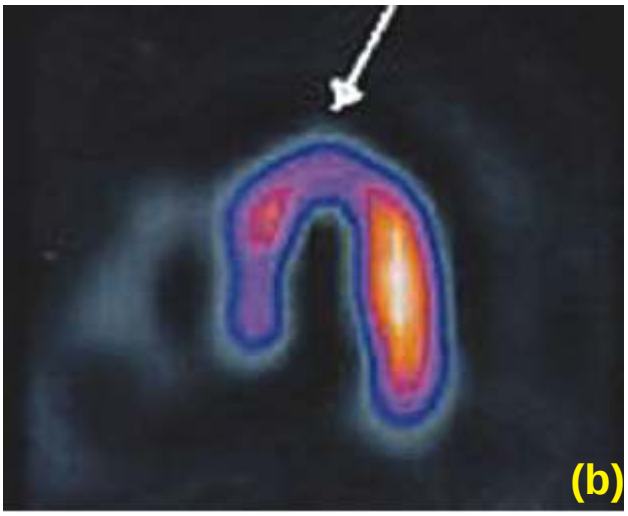


Figure 2. Number of segments reported normal or abnormal at rest and stress using the two reporting methods.





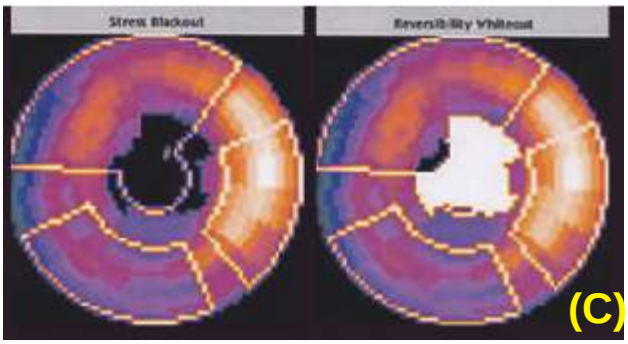


Figure 3. Patient with apical defects seen well on the observer read stress (a) and rest (b) slices and the bull's eye plot (c)

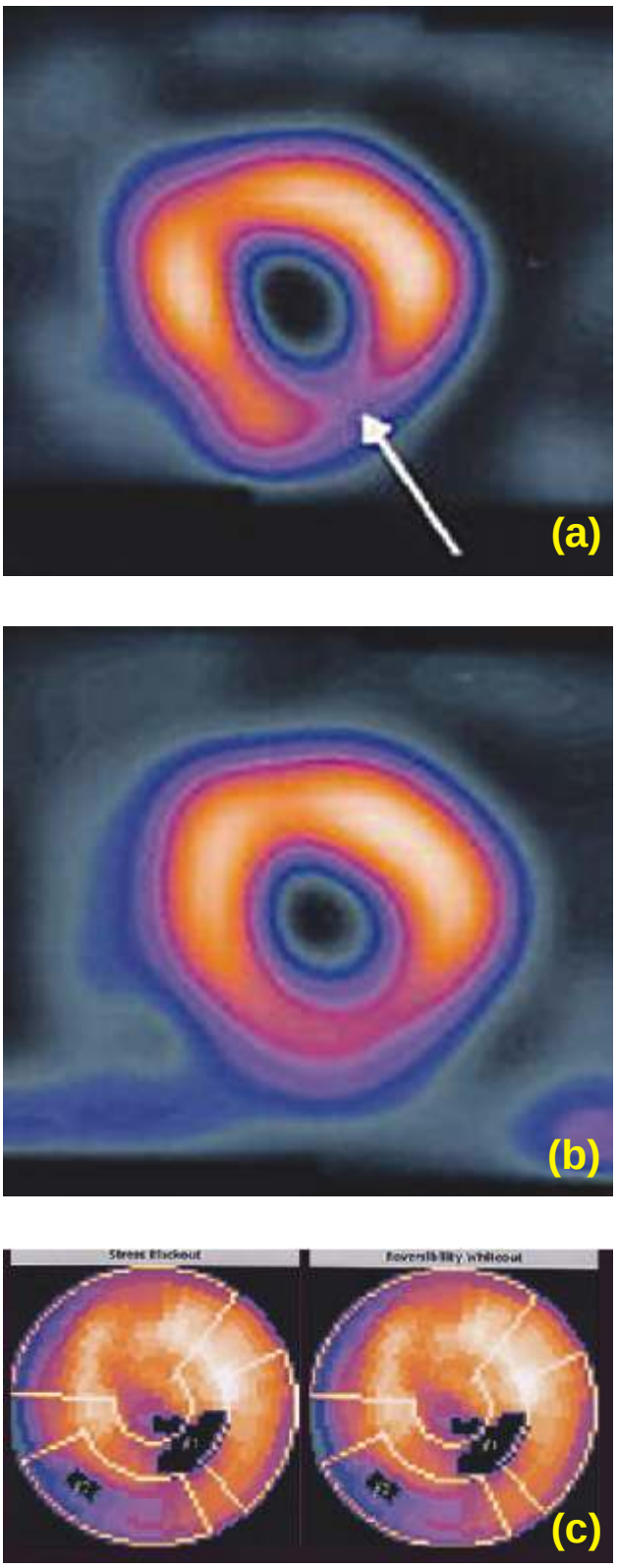


Figure 4. Discordant result with defect in infero-lateral wall seen on stress (a), reperfusing at rest (b), but re-perfusion not confirmed on bull's eye plot (c).

in the resting image.

Quantification was performed using the Emory bull's eye system with a pixel-by-pixel comparison with actual gender and age matched normal controls. The results of the quantitative reporting was described by the programme as normal, ischaemia and infarct. Any defect if found was then correlated with the scintigraphic pattern of the region observed by the quantitative reporting as described before.

Results

The numbers of abnormal segments seen on the qualitative reading of the images were 119 at stress and 79 at rest (Figure 2). In the bull's eye plot 98 abnormal territories were seen at stress and 76 abnormal territories were seen at rest. 33 segments (10%) were found abnormal on the qualitative reading of the images alone and 7 (2%) were reported abnormal on bull's eye alone. In the majority of cases there was a clear correlation between the two reading techniques, especially in cases of clearly defined ischaemic lesions in the territory of the left anterior descending artery (Figure 3). A total of 55 segments were reported as ischaemic on qualitative reading of the images, while 26 (48%) of them were reported normal on bull's eye. Thirteen of these segments were in the right coronary artery (RCA) territory, 8 in the Left coronary artery (LAD) territory and 5 in the left circumflex territory. In areas away from the anterior wall there was a higher rate of discordance with what appeared to be areas of clear cut ischaemia in the inferior lateral wall, which on quantitative analysis appeared to be normal (Figure 4).

A total of 67 segments were reported as infarct on qualitative reading of the images, 10 (13%) of these`were reported normal on bull's eye. Seven of these segments were in the territory of the right coronary artery (RCA), 1 in the Left coronary artery (LAD) territory and 2 in the left circumflex territory segments.

In some patients there appeared to be discordance in both, the site and significance in lesions seen, so that the area stated as abnormal on one reading technique could be very different from that in the other reading technique (Fig 5).

Discussion

The results of this study show that there is a significant difference in the results of reporting scans using a bull's eye plot when compared to the visual reading of the tomographic slices. This was especially noticeable in identifying inferior wall ischaemia as there could be a number of factors causing this difference. Examples could be the way in which the computer programme and the reader handles such issues as non-uniform attenuation, Compton scatter, and limited spatially varying resolution. All of these could degrade both the qualitative and quantitative nature of myocardial perfusion SPECT (3).

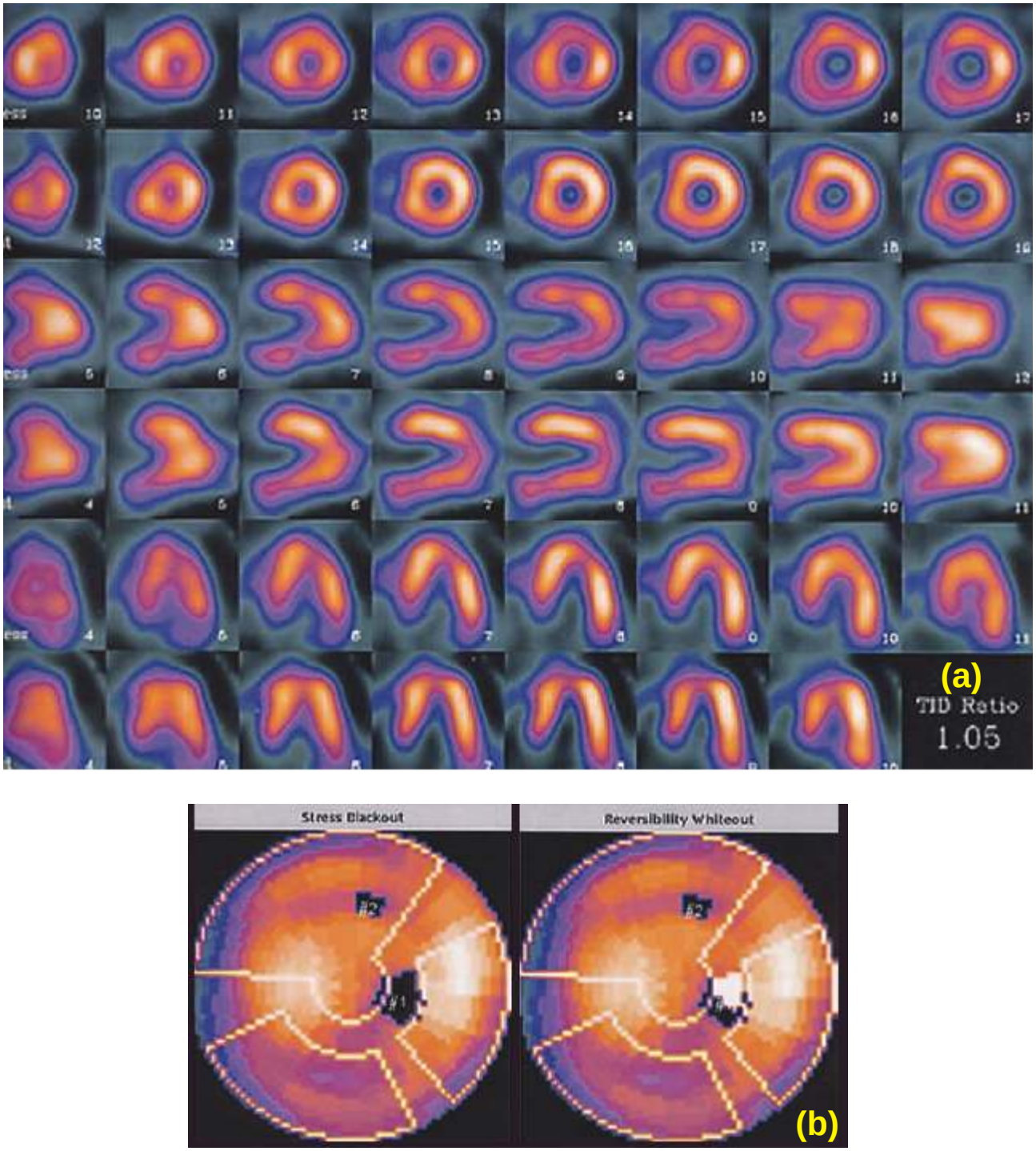


Figure 5. Multiple stress and rest slices (a) of a patient in whom there appears little concordance with the results of a bull's eye plot (b)

There are a number of important limitations and potential for error in these quantification methods, which must be emphasised. Though described as objective, the reliability of the bull's eye plot is dependent on the observer's correct selection of apex and base of the left ventricle from the oblique tomographic slices. The basal potion of the ventricle is relatively magnified in the bull's eye plot and that regions near the apex are minified, basal perfusion abnormalities will appear larger than equivalent defects in the middle and distal portions of the LV (2). There are other image artefacts resulting in decreased count density, such as attenuation by large breasts, elevated hemi-diaphragm. Patient motion could appear as defects in the bull's eye plot especially if this results in a mis-registration of the rest and stress polar plots. Also a skilled observer would spot the typical appearances of movement artefact on the scan and

would take them into consideration while reporting and interpreting the results. The normalized activity values of Tc-99m Sestamibi in the inferior wall differ significantly between men and women. Similarly variations in scintigraphic patterns are also seen for men in the anterior wall (4). The pattern of disease varies in each geographic region and it presents differently in different systemic diseases. Even alteration in myocardial anatomy and symmetry may create relative abnormality in patient data as compared with normal gender-matched files. Standard criteria for assigning perfusion defects to a specific vascular territory often result in mistaken identification of the affected coronary artery due to the normal variability of coronary anatomy (5). Therefore there are significant differences in the results of scans reported using a bull's eye plot, especially in identifying inferior wall ischaemia. The risk of obtaining a false-positive test result in subjects undergoing Tc-99m Sestamibi myocardial SPECT with a very low likelihood of CAD was higher than anticipated (6). Finally in the recent years, a number of Tc-99m labeled myocardial perfusion imaging agents have been developed. Even though these tracers have more or less similar scintigraphic appearance, there are subtle differences in the myocardial kinetics and bio-distribution. Although SPECT normal data files of various radiopharmaceuticals are not statistically different, they are not identical either. It appears, nevertheless, prudent to use radiopharmaceutical-specific normal data files for quantitative analysis of SPECT images (7). Before using such a quantification method a full assessment of the accuracy of each method should be performed. We should also think in terms of having a regional, database or to be more specific we should aim in terms of having a local hospital database based on the type of patients we scan routinely. Improvements in these directions will help us to interpret better with greater confidence and send in the value-based information to the physicians which in turn help them to manage the patients.

Conclusion

There are significant differences in the results of reporting scans using a bull's eye plot especially in identifying inferior wall ischaemia. Therefore before using such a quantification method a full assessment of the accuracy of each method should be performed. So achievement in this direction will improve the diagnostic accuracy and cost-effectiveness of myocardial perfusion SPECT.

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