Qualitative and quantitative assessment of regional left ventricular wall thickening in short axis MR images of patients with coronary artery disease using z-score for comparison to a normal database.

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Introduction

Detection of regional left ventricular wall thickening abnormalities at rest and under stress conditions is a major concern in the evaluation of coronary artery disease. Since visual assessment depends on the subjectivity of the observer, quantitative analysis is of primary interest. The purpose of this study was to quantify the left ventricular wall thickening in patients with multi-vessel coronary artery disease and to compare it to both visual analysis and a normal range.

Methods

Fourteen patients (12 men, 2 women/ mean age 62 years) who had ischaemic heart disease with left ventricular impairment, from angiography, and were scheduled for coronary artery bypass grafting within two weeks were examined. Multiple temporal cine-MR images were obtained in the short axis, positioned using the end-systolic long axis view as the frame of reference, using a breatheld segmented k-space sequence, with a frame separation of 80 ms and seven cardiac phases. Four non-contiguous slices were imaged that covered the length of the left ventricle. MR data was transferred to a PC and wall thickening quantitatively determined using a semi-automated 3D centre-line method [1]. Data was acquired in 16 segments, 4 per slice. The quantitative wall thickening analysis was compared to a data-base of 11 normal volunteers (6 men, 5 women) using a calculated z-score to assess the difference and to a visual analysis of corresponding segments to distinguish those with clinically relevant reduction from other regions.

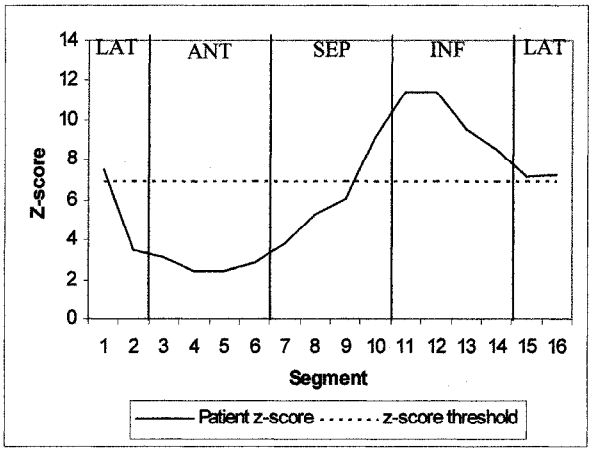

Figure 1. Patient example of calculated z-score compared to z-score threshold (=7).

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Results

Of the 176 segments available, all were amenable to automated quantitative analysis and 171 (97%) to qualitative observer analysis.

Figure 1 shows an example of calculated z-score, describing the difference in patient wall thickening compared to that of a normal range, in 16 segments round the left ventricular short axis image.

For all patients, 65 segments were scored abnormal by the observer and 106 normal. These were used as the gold standard for the determination of the z-score threshold. Table 1 shows the variation of sensitivity, specificity and accuracy with z-score threshold. The best compromise being given with a threshold of 7, equating to a sensitivity of 77% (50/65), a specificity of 75% (79/106) and a total accuracy of 0.76 (129/171).

Discussion

Reduced myocardial wall thickening plays an important role in the determination of myocardial viability. This was readily assessed in patients with coronary artery disease using a calculated z-score to determine the degree of reduction compared to a normal data base. Comparison to qualitative assessment by an observer allowed the selection of a z-score threshold to give optimised sensitivity, specificity and accuracy.

Conclusion

We have shown that comparison to a normal range using calculated z-scores is a feasible way of determining clinically relevant reduction in myocardial wall thickening.

THRESHOLD (Z-SCORE)	SENSITIVITY	SPECIFICITY	ACCURACY
1	100.0	11.32	0.45
2	96.92	16.89	0.47
3	93.85	27.35	0.53
4	90.77	36.79	0.57
5	87.69	48.11	0.63
6	86.15	61.32	0.71
7	76.92	74.53	0.76
8	66.15	82.07	0.76
9	52.31	86.79	0.74
10	41.54	88.68	0.71
11	32.31	93.40	0.70
12	20.00	96.23	0.67
13	12.31	97.17	0.65

Table 1. Sensitivity, specificity and accuracy of thresholded z-score for determining abnormal wall thickening.

References
1. Waiter GD et al "Proc. ISMRM Workshop on Cardiovascular MRI", London, (1999)