

# Poor tracking of myocardial walls and inaccurate estimation of systolic parameters in myocardial hypertrophy on gated myocardial perfusion SPECT resulted from erroneous placement of region of interest and contouring: A pitfall of commercially available software packages for cardiac analysis

Mohsen Qutbi, MD,<sup>a</sup> Yaser Shiravand, MD,<sup>a</sup> Mehdi Soltanshahi, BSc,<sup>a</sup> Isa Neshandar Asli, MD,<sup>a</sup> and Abdolhamid Bagheri, MD<sup>b</sup>

<sup>a</sup> Department of Nuclear Medicine, Taleghani Educational Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>b</sup> Department of Cardiology, Modarres Educational Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Received Jun 22, 2018; accepted Jul 5, 2018  
doi:10.1007/s12350-018-1369-6

## INTRODUCTION

Hypertrophic cardiomyopathy (HCM) is a heritable disorder which is characterized by increased thickness of the ventricular walls, symmetric or asymmetric, with preserved or even hyperdynamic systolic function. Marked thickening of the septum causes obstruction in outflow tract.<sup>1</sup> The asymmetric form, to a greater extent, poses tough challenges in SPECT myocardial perfusion imaging (MPI). One of the well-described challenges is downscaling artifact in nonhypertrophied walls in perfusion images. The quantitation of left ventricular (LV) function is affected as well.<sup>2,3</sup> In the present note, it is intended to present a case with marked hypertrophy in whom this condition compromises the SPECT images by erroneous placement of the regions of interest (ROI) during analysis using Cedars-Sinai software.

## CASE SUMMARY

A 31-year-old male with a known history of hypertrophic obstructive cardiomyopathy (HOCM) was referred for cardiac evaluation prior to kidney transplantation. Electrocardiography and echocardiography were consistent with marked hypertrophy of LV, much more prominent in the septal region (Figure 1). A stress-rest Dipyridamole SPECT MPI was conducted. SPECT images were reconstructed with iterative method and then analyzed and displayed in Cedars-Sinai software. Marked hypertrophy of the LV as well as severe hypokinesia of septal wall and reduced global EF (41% compared to almost normal EF in echocardiography) were noted. Otherwise, the study was negative for any distinct ischemia. Reviewing the accuracy of the quantitative analysis during routine quality checking, revealed that contours of the walls, particularly of septum, were poorly drawn on the endocardial surface (Figures 2 and 3).

## DISCUSSION

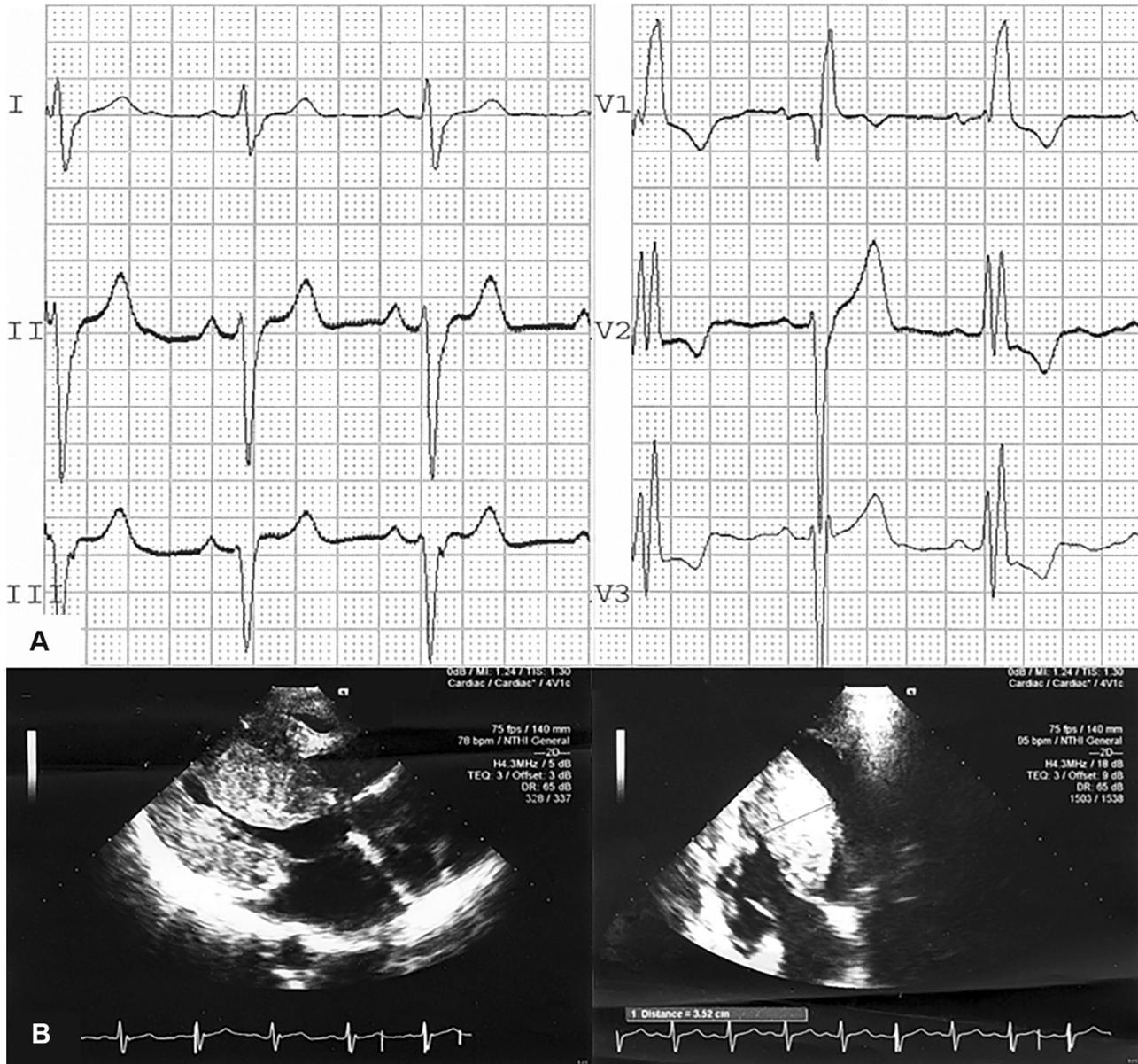
Myocardial hypertrophy, secondary or unrelated to hypertension, is occasionally encountered in patients undergoing SPECT MPI. In addition to artifacts pertinent to perfusion, particularly in asymmetric septal hypertrophy, the quantitative analysis is deeply

Reprint requests: Mohsen Qutbi, MD, Department of Nuclear Medicine, Taleghani Educational Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Yaman St., Velenjak, Tehran 1985711151, Iran; [mohsen.qutbi@gmail.com](mailto:mohsen.qutbi@gmail.com)

J Nucl Cardiol 2019;26:1376–9.

1071-3581/\$34.00

Copyright © 2018 American Society of Nuclear Cardiology.

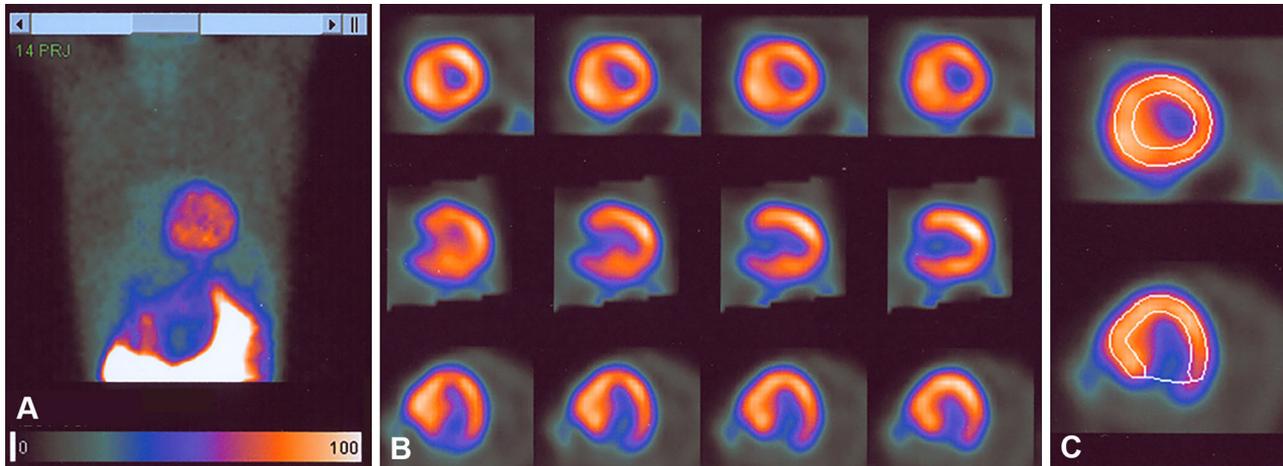


**Figure 1.** (A) Electrocardiography of the patient (only leads I, II, III, V1, V2, and V3 are shown) reveals a normal sinus rhythm, right bundle branch block, right axis deviation and a widened QRS complex (16 ms). (B) Echocardiography demonstrated marked septal hypertrophy with a diameter of 32 mm and preserved systolic function of LV (EF roughly equals 60% or more). Resting peak gradient of LV outflow tract obstruction was estimated 99 mmHg. The findings were consistent with type 3 HCM.

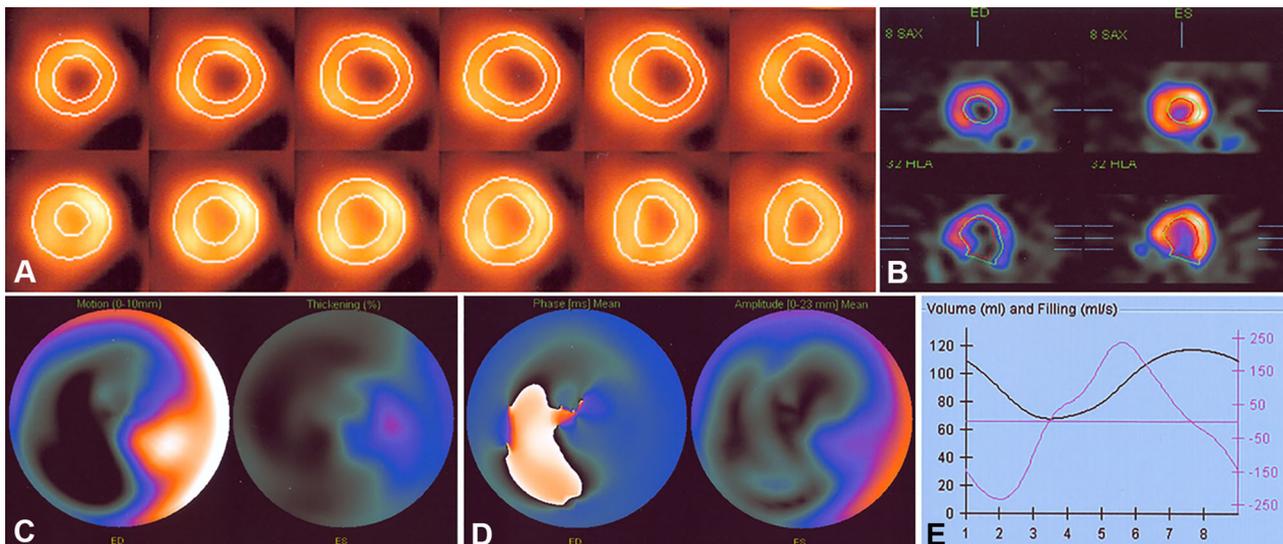
influenced in various ways. The thickening of septal wall is mainly reduced as a result of decrease in partial volume effect, when count-based method is employed. But motion, LV volumes and LV EF are affected by a different mechanism. The basic mechanism underpinning this issue is that the algorithms responsible to detect edges are not capable to accurately define the contours of LV walls in hypertrophied regions.<sup>2</sup> Similar

to that seen in situations where an extracardiac hot spot immediately adjacent to myocardial walls compromises accurate definition of LV contours.

One of the earliest and most important steps in processing of medical images, as in SPECT images, is drawing of the ROIs around the object of interest (OOI). By this means, the OOI is identified and regional data can be extracted for more advanced quantitative



**Figure 2.** (A) An anterior projection of raw SPECT image shows enlarged LV with almost obliterated cavity. (B) A few slices of SPECT in short axis, vertical and horizontal long axis reveal markedly thickened septum compared to other walls. (C) Slices with contours overlaid on LV walls. Endocardial and epicardial contours are almost equidistantly drawn throughout the LV walls, which are erroneous in septal region as a result of exceptional thickness. Parts of myocardium at epicardial and endocardial surfaces at septal region lie outside the LV ROI. The erroneous contouring is much more prominent on the endocardial surface and thus, a greater extent of miscalculation of LV cavity is present.



**Figure 3.** (A) upper and lower rows demonstrate short axis slices at end diastolic (ED) and end systolic (ES) phases, respectively. The mentioned erroneous contouring is persistently present during the cardiac cycle, but more marked at ES phase. In contrast, visually, a significant decrease in LV volume is visible from ED to ES. Endocardial ED (green) and ES (red) contours are drawn on the same image as seen in (B). Both contours are superimposed on each other in septal region indicating severe decline in motion from ED to ES. Almost concordant results are seen in polar plots of motion and thickening (C), although some degree of thickening is visible in plot of thickening, as well as phase and amplitude plots (D) at septal region. (E) Time activity curve demonstrates a considerable decrease in EF as well as overestimated ES volume.

analysis. The ROIs around the LV walls in cardiac SPECT images are drawn automatically by edge detection algorithms, generally using the Laplacian method to identify edges where the values in adjacent pixels change rapidly. A high degree of accuracy is achievable with more sophisticated algorithms developed and included in the newer versions of commercially available software packages for cardiac analysis. When the segmentation of LV is satisfactorily achieved, the next step is to define the exact location of the inner and outer surfaces of the LV. A common method to accomplish this purpose, as in Cedars-Sinai approach, is approximating the values of the pixels or voxels along a sampling ray with an asymmetric Gaussian distribution in that the maximum of the curve coincides with the midmyocardial point. The inner and outer surfaces are statistically estimated based on a predefined, fixed number of standard deviation (SD). At Cedars-Sinai approach, the myocardial wall thickness is assumed fixed in the ranges that is typically expected in normal hearts. This error in wall contouring in hypertrophied myocardium leads to inaccuracy in calculation of LV volumes and EF, poor tracking of walls, and subsequently wall motion abnormality.<sup>4-6</sup>

SPECT MPI, although a useful and validated modality for quantification of LV function, has limitations in some circumstances like in our case. In such circumstances, although the quantitative analysis is profoundly compromised as the result of erroneous contouring and placement of ROI, the visual estimation of the LV systolic function is a beneficial alternative. The degree of hypertrophy in most cases is much less than that in the index case, thus, the error in wall contouring and thus incorrect calculation of LV volumes

and EF may not be readily noticeable. A multimodality approach to evaluate such patients may be favorable. Therefore, checking the correct placement of ROIs should be an indispensable part of cardiac SPECT analysis and interpretation by nuclear medicine practitioners.

## Disclosure

*No conflict of interests is declared. No fund or financial support was assigned to this project.*

## References

1. Marian AJ, Braunwald E. Hypertrophic cardiomyopathy: Genetics, pathogenesis, clinical manifestations, diagnosis, and therapy. *Circ Res* 2017;121:749-70.
2. Jaber WA, DiFilippo FP, Cerqueira MD. Left ventricular hypertrophy and SPECT myocardial perfusion imaging: Finding the diamonds in the rough. *J Nucl Cardiol* 2007;14:398-407.
3. Ghai A, Horn E, Pearson G, Bokhari S. Significant left ventricular hypertrophy on SPECT imaging in a patient with hypertrophic cardiomyopathy: A comparative image with cardiac magnetic resonance. *J Nucl Cardiol* 2005;12:605-6.
4. Germano G, Kavanagh PB, Slomka PJ, Van Kriekinge SD, Pollard G, Berman DS. Quantitation in gated perfusion SPECT imaging: The Cedars-Sinai approach. *J Nucl Cardiol* 2007;14:433-54.
5. Lin GS, Hines HH, Grant G, Taylor K, Ryals C. Automated quantification of myocardial ischemia and wall motion defects by use of cardiac SPECT polar mapping and 4-dimensional surface rendering. *J Nucl Med Technol* 2006;34:3-17.
6. Cherry SR, Sorenson JA, Phelps ME. Digital image processing in nuclear medicine. In: Cherry SR, Sorenson JA, Phelps ME, editors. *Physics in nuclear medicine*. Philadelphia: Elsevier Saunders; 2012. p. 363-78.