An assement of free breathing on image quality for visual and semi quantitative cardiac perfusion

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Introduction: The assessment of myocardial perfusion can be performed either with exercise or pharmacological vasodilatives such as adenosine. Adenosine is a respiratory stimulant and intravenous administration of it has shown to increase minute ventilation and reduce arterial PCO_2 causing respiratory alkalosis. Many patients experience dyspnea or an urge to breath deeply. Due to this effect, breath holding the patient during the stress part of a myocardial perfusion exam can be difficult. In this paper, we present our experience with free breathing rest and adenosine stress myocardial perfusion.

Materials and Methods: Twenty patients with suspected CAD were included for first pass perfusion study under stress and rest. All the patients were consented by the cardiologist. Cardiac stress was achieved with intravenous administration of adenosine vasodilation (Adenoscan, Fusjisawa, Deerfield, IL) and the perfusion images were acquired with a single dose of gadodiamide (Omniscan, Amersham Health, Princeton, NJ). All exams were performed on a Philips Intera 1.5 T CV system (Philips Medical Systems, The Netherlands) equipped with Master gradients. A five channel phased array cardiac coil was used with the patients oriented in supine position. A single shot segmented k-space turbo field echo sequence with a TR and TE of 2.8ms and 0.93ms was the sequence of choice. Three slices of 10 mm thick with a gap of 8 mm were planned to yield basal, mid and apical locations of left ventricle (LV) in the short axis orientation. All the three slices were acquired in a single heartbeat with saturation prepulse applied over the three slices and under free breathing. Translation and rotation of stress and rest images were measured using an EasyVision (R 5.2) workstation (Philips Medical Systems, The Netherlands). Mean and standard deviation of the translation and rotation were calculated and also the mean difference of rest and stress data. Two of the cardiologists performed the qualitative assessment of both stress and rest perfusion. Stress and rest perfusion quantitative analysis was performed using an EasyVision semi-quantitative (SQ) perfusion package. Image registration was done for motion correction and automatic quantitation was done by drawing endo and epi cardial contours.

Results: Segmental analysis was done according to AHA guidelines and bulls-eye plot is made (Fig 1). Myocardial perfusion reserve index (MPRI) was calculatred by dividing the maximum vasodilation at stress by rest. The threshold for MPRI was set at 1.1 as observed by Nagel et.al.[1].

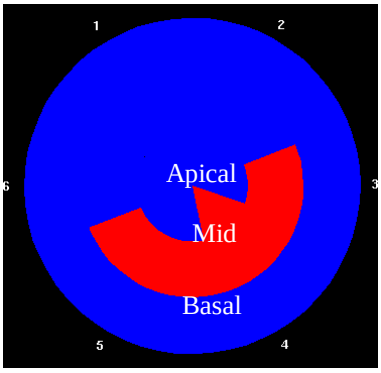
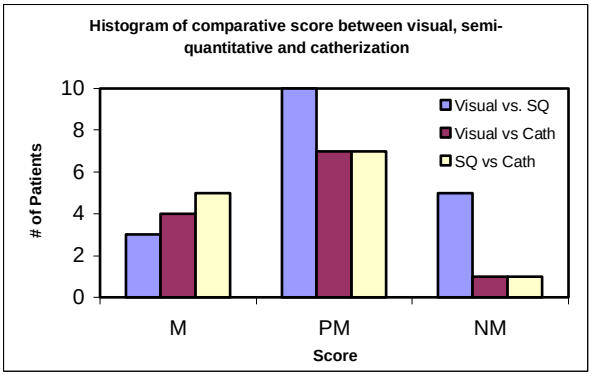


Figure 1: Bull's Eye plot of MPRI thresholded to 1.1 for 3 slices (Red being underperfused and blue being normal)

The results from SQ were compared to the visual assessment as well as to the results from cardiac catherization (cath) and/or cardiac echo. SQ analysis was not done on 3 patients either due to poor image quality or due to non-availability of the rest data. One patient's cath report was more than 7 month old and for four patients the cath reports were not available and hence they were from the comparative study. One patient data was rejected as the patient had coffee within 24 hours before the exam. The histogram of the comparative results is shown in figure 2. Three categories were used for scoring with Match (M) being 1 to 1 correlation and Partial Match (PM) being atleast one correlation and No Match (NM) being zero correlation.



Conclusion: The mean and standard deviation of translation are 14±4.5 mm and 11.2±4.2 mm and rotation are 7.3±4.2° and 6.6±3.3° of stress and rest images respectively. The mean difference between stress and rest is 25.6% for translation and 10.3° for rotation, respectively. This reinforces the fact that the motion during stress is greater than rest. The good correlation between SQ and visual and other techniques establishes that perfusion could be done under free breathing for those patients who will find it difficult to hold their breath. The image registration part of the SQ tool for this amount of translation and rotation works very well. Increase in resolution would increase the chances for better automated contour detection and hence better quantitation. Work needs to be done comparing perfusion data with and without free breathing to completely understand the effect of breathing on quantitation and hence on the diagnosis.

Reference:

1. Nagel E, Klein C, Paetsch I, Hettwer S, Schnackenburg B, Wegscheider K, Fleck E. Magnetic resonance perfusion measurements for the noninvasive detection of coronary artery disease. Circulation. 2003;108:432-7.