The diagnostic value of myocardial perfusion imaging in diagnosing coronary artery stenosis in patients suspected of coronary artery disease

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ABSTRACT

Coronary heart diseases are the second reason for death therefore their prevention, early detection and treatment is important. Myocardial perfusion imaging is a diagnosis tool for Coronary Artery Disease (CAD), but it has false positive and false negative results. This study aimed to define the diagnostic value of myocardial perfusion diagnosis of coronary artery stenosis in patients suspected of coronary artery disease. This study was done on 170 patients who underwent coronary angiography and perfusion scan was in their medical records. To collect data, medical records of patients who had coronary angiography and myocardial perfusion imaging in their medical records were identified and selected. Demographic information, patient history and extent of coronary artery stenosis which was measured by angiography software quantitatively were recorded in a check list. The results of reported perfusion scans were evaluated and compared with the results of angiography. From 170 patients, 84 patients (49.4%) were male and (50.9%) were female and 100% were married. The mean age was 56.6 ± 9.3 years with the range of 27-84 years. The results showed that the sensitivity of myocardial perfusion imaging for coronary artery was 88.5%, specificity 50.6 %, positive predictive value 65.3% and negative predictive value was 80.8 %.Myocardial perfusion imaging has high sensitivity and should be considered as a non-invasive screening test in diagnosing coronary heart diseases. However, because of its low specificity decision should be made beside other clinical findings.

KEY WORDS: Myocardial perfusion imaging, coronary heart disease, coronary artery stenosis, angiography.

1. INTRODUCTION

In recent years, cardiovascular diseases have become an epidemic problem in advanced and developing countries. Cardiovascular diseases are the foremost reason of death in the world, accounting for more than 17.3 million deaths per year, a number that is expected to grow to more than 23.6 million by 2030. The disease has economic, social and health consequences. Screening and understanding the disease before the onset of serious disabilities are the most important steps for second level of preventing (Longo, 2012, Harrison, 2015). The objective of non-invasive methods in patients with stable symptoms is to define the presence or absence of coronary disease and long-term prognosis for adverse effects over time (Sadeghian, 2016). One of the common and non-invasive diagnostic methods of coronary artery disease is myocardial perfusion scan. The most common procedure used in nuclear medicine is SPECT (Single Photon Emission Computed Tomography). After injection of radio pharmaceuticals isotopes are removed from the blood by living myocytes and stay in the myocardium for a specified period of time. Photons emitted in accordance with blood up taking from the myocardium which depends on the amount of perfusion. Gamma camera receives emitted photons and converts them to digital information; this function represents the rate of uptake and the place of release of photons. The result of SPECT images is a multiple tomogram which creates a cross-sectional image of the target organ and represents the distribution of radio pharmaceuticals throughout the organ (Farag and Hage, 2014).

Sensitivity for detection of coronary artery disease with exercise myocardial perfusion method is 87% (71-96%) and specificity for ruling out the coronary artery disease is about 73% (36-100%) (Libby and Braunwald, 2008). Coronary angiography is the gold standard method for evaluating and defining coronary artery disease. Coronary angiography is used to identify the exact location and severity of CAD. It provides reliable anatomical information to determine medical treatment or revascularization (Johansen, 2006). Heart catheterization is important clinically to evaluate heart lesions when it cannot be evaluated by non-invasive methods. Its risk of major complications is 1% and the mortality rate is around 0.08% (Hang, 2013). Abnormal perfusion findings in patients lacking important coronary artery narrowing at coronary angiography have been considered false-positive. Several factors have been described to affect the specificity of radionuclide perfusion imaging. These include the type of acquisition and the criteria for interpretation and analysis. Factors frequently associated with false-positive stress perfusion findings are the female sex, angina with normal coronary arteries (syndrome X), left bundle branch block, cardiomyopathy, and mitral valve prolapsed (Arai, 2007).

2. MATERIALAS AND METHODS

This diagnostic test study was conducted on patients referred to Imam Ali Hospital in Kermanshah, Iran from March 2014 to September 2015 who underwent coronary angiography and perfusion scan was in their medical records (Rasolabadi, 2015). Assuming the sensitivity as 87%, alpha as 0.05 and accuracy of 2% the sample size was estimated as 170 patients.

Data collection tool in this study was questionnaire which designed based on the variables. Demographic data and medical history of participants including; gender, age, education, marital status, history of diabetes, history of hypertension, history of smoking and history of myocardial infarction was recorded also the reports of perfusion scan for each patient recorded in questionnaire (Rasolabadi, 2015). Finally angiography videos as the gold standard were reviewed in order to compare the angiography results with perfusion scan results.

In order to collect data, medical records of patients who have had coronary angiography and myocardial perfusion imaging in their medical records were identified and selected. Demographic information, patient history and degree of coronary artery stenosis which was measured by angiography software quantitatively were recorded in a check list. Data were analyzed using SPSS software. The results for quantitative variables were presented as mean and standard deviation (mean ± SD) and foe qualitative variables as a percentage. The sensitivity, specificity, positive predictive value and negative predictive value for coronary perfusion scan in different coronary vessels were calculated.

3. RESULTS

Of the 170 patients, 84 patients (49.4%) were male and 86 patients (50.6%) were female and 100% were married. The mean age was 56.6 ± 9.3 years with the range of 27-84 years. Total of 50.6% of patients had the history of high blood pressure and 25.9% had the history of myocardial infarction (Table.1). In terms of coronary artery stenosis 51.8% were without stenosis. In 18.8% one vessel, in 11.8% two vessels and in 17.6% three vessels had stenosis.

The results showed that stenosis severity in right coronary artery (RCA), left circumflex (LCX) and left anterior descending (LAD) were 22.9%, 27.7% and 37.6% respectively. (Table.2)

The results showed that the sensitivity of myocardial perfusion imaging for coronary artery was 88.5%, specificity 50.6 %, positive predictive value 65.3% and negative predictive value was 80.8 %. Sensitivity (91.5%), specificity (46.5%), positive predictive value (55.1%) and negative predictive value (88.5%) of myocardial perfusion imaging for the diagnosis of LAD artery involvement were better than the two other vessels.

Test myocardial perfusion imaging in all three coronary vessels had the sensitivity of 88.5%, specificity of 50.6%, and positive predictive value of 65.3% and negative predictive value of 88.5%, respectively. (Table 3)

Table.1. Frequency distribution of risk factors for the subjects

Frequency Variable	Yes No. (%)	No No. (%)
History of Diabetes	35(20.6)	135(79.4)
History of high blood pressure	86(50.6)	54(49.4)
Smoking	79(46.5)	91(53.5)
History of myocardial infarction	44(25.9)	126(74.1)

Table.2. Frequency distribution of RCA stenosis severity in subjects

Coronary arteries Severity of stenosis	RCA No. (%)	LCX No. (%)	LAD No. (%)
Mild (less than 50%)	119 (70)	121 (71.1)	99 (58.2)
Moderate (50-70%)	12 (7.1)	2 (1.2)	7 (4.2)
Sever (More than 70%)	39 (22.9)	47 (27.7)	64 (37.6)
Total	170 (100)	170 (100)	170 (100)

Table.3. comparing the results of myocardial perfusion imaging with angiography in different coronary vessels

Angiography Myocardial perfusion imaging		Abnormal No. (%)	Normal No. (%)	Sensitivity	Specificity	positive predictive value	negative predictive value
RCA	Positive	45 (88.2)	73 (61.3)	88.2	38.7	38.1	88.5
	Negative	6 (11.8)	46 (38.7)				
LCX	Positive	44 (89.8)	74 (61.2)	89.8	38.8	37.2	90.4
	Negative	5 (10.2)	47 (38.8)				
LAD	Positive	65 (91.5)	53 (53.5)	91.5	46.5	55.1	88.5
	Negative	6 (8.5)	46 (46.5)				
Three Vessels	Positive	77 (85.5)	41 (49.4)	88.5	50.6	65.3	80.8
	Negative	10 (11.5)	42 (50.6)				

DISCUSION

In patients with CAD, non-invasive, precise investigation to detect ischemia, its extent and severity of CAD is useful to prevent invasive diagnostic methods such as angiography. In our study the results showed that the sensitivity of myocardial perfusion imaging for coronary artery (RCA, LCX and LAD) was 88.5%, specificity 50.6%, positive predictive value 65.3% and negative predictive value was 80.8 %. In a study by Bhutani which was conducted to define the accuracy of SPECT imaging for detection of CAD in patients with end stage liver disease (ESLD), adenosine SPECT imaging had a sensitivity of 62%, specificity of 82%, positive predictive value of 30%, and negative predictive value of 95% for diagnosing severe CAD. Regadenoson SPECT imaging had a sensitivity of 35%, specificity of 88%, positive predictive value of 23%, and negative predictive value of 93% for diagnosing severe CAD (Bhutani, 2013).In a study by Wang, the overall sensitivity and specificity for detecting CAD for patients with > 70% stenosis was 95% and 75% respectively. They concluded that pharmacologic myocardial perfusion SPECT is safe and diagnostically precise for CAD detection in very elderly patients (WANG, 1995).

Schaap, evaluated the performance of hybrid SPECT/CCTA vs. standalone SPECT and CCTA for the diagnosis of coronary artery disease. SPECT had a sensitivity of 93%, specificity 79%, positive predictive value 85%, and negative predictive value 89%. CCTA had a sensitivity of 98%, specificity 62%, positive predictive value 77%, and negative predictive value 96%. Hybrid analysis of SPECT and CCTA improved the overall performance: sensitivity, specificity, positive predictive value, and negative predictive value for the presence of significant CAD to 96, 95, 96, and 95%, respectively (Schaap, 2013). In a study by Nasis, the diagnostic correctness of combined 320-detector row computed tomography coronary angiography (CTA) and adenosine stress CT myocardial perfusion imaging (CTP) in spotting perfusion abnormalities caused by obstructive coronary artery disease (CAD) was determined. They concluded that combined 320-detector CTA/CTP is accurate in identifying obstructive CAD causing perfusion abnormalities compared with combined QCA/SPECT-MPI, achieved with lower radiation dose than SPECT-MPI (Nasis, 2013).

Another study conducted to assess the accuracy of exercise methoxy isobutyl isonitrile (MIBI) single photon emission computed tomography (SPECT) in the evaluation of the extent of coronary artery disease (CAD) in patients with an earlier myocardial infarction. The sensitivity and specificity were 95% and 55% respectively (Elhendy, 2000).

In a study by Hannoush, predictive accuracy and impact of myocardial perfusion imaging on clinical practice was analyzed. Results showed that the positive and negative predictive values of myocardial perfusion imaging were 91% and 86%, respectively (Hannoush, 2003). Beiki, compared accuracy of myocardial perfusion scan with stress test. Myocardial perfusion scan sensitivity was 94%, specificity 94%, positive predictive value 96%, and negative predictive value 92%.They concluded that myocardial perfusion scan is of unlimited value in detection of CAD with sensitivity and specificity far better than exercise stress test (Beiki, 20070. In a study by Alavi the sensitivity and specificity were 91.2% and 86.6% respectively (Alavi, Moula and Nabavizadeh, 2000).The calculated sensitivity in our study is almost similar to previous studies, but the specificity is lower. It seems that technical, professional and the equipment may affect myocardial perfusion imaging results.

In the present study the sensitivity, specificity, positive predictive value and negative predictive value for RCA were 88.2%, 38.7%, 38.1% and 88.5% respectively. For LCX sensitivity, specificity, positive predictive value and negative predictive were 89.8%,38.8%,37.2% and 90.4% respectively and for LAD sensitivity, specificity, positive predictive value and negative predictive were 91.5%,46.5%,55.12% and 88.5% respectively. In a study by Kang, the localization of myocardial ischemia by exercise electrocardiography and myocardial perfusion SPECT were compared. Data showed that myocardial perfusion SPECT correctly identified the most stenotic coronary disease for LAD (94%), LCX (72%), and RCA (75%) (Kang, 2000). In Elhendy study the sensitivity rates for the diagnosis of left anterior descending coronary artery, left circumflex, and right coronary artery based on any defect were 80%, 70%, and 63%, respectively. The corresponding specificity rates were 70%, 76%, and 73%, respectively (Elhendy, 2000).

In a study by Alavi, sensitivity for LAD, LCX, RCA were 96%,54.8%,72.2% and specificity were 75%,75% and 74.15 respectively (Alavi, Moula and Nabavizadeh, 2000).In terms of sensitivity the findings of these studies were somewhat similar to our study, but in terms of the specificity they were no in consistent with ours.

In our study by increasing the number of stenotic coronary arteries sensitivity, specificity, positive predictive value and negative predictive value increased. Miller and Mahmarian in their studies showed that the sensitivity of myocardial perfusion imaging is low when one coronary artery is stenotic compared to when two or three arteries are stenotic (Miller, 2001, (Mahmarian, 1997).

The use of myocardial perfusion imaging has high diagnostic and prognostic value. In a study which conducted to analyze the relative risk of different variables in patients with abnormal perfusion the results revealed that myocardial perfusion defects found by SPECT imaging are independently predictive of long-term all-cause death (Diaz, 2001). Yao and Rozanski in a study confirmed the value of myocardial perfusion imaging in determining the risk of subsequent cardiac events (Yao and Rozanski, 2001). Khanna examined the prognostic implications of normal exercise tomographic thallium images in medically treated patients with angiographic evidence of coronary artery disease. He concluded that medically treated CAD patients including those with multi-vessel CAD have a benign prognosis in the presence of normal exercise thallium images (Khanna, 2000). Myocardial perfusion imaging technique, besides providing acceptable diagnostic information economically is affordable and will prevent unnecessary additional costs and repeated medical visits. Myocardial perfusion imaging is recommended immediately for patients with chest pain and risk factors for coronary artery disease (Shoyeb, 2003).

4. CONCLUSION

With regard to sensitivity of myocardial perfusion imaging in the diagnosis of coronary artery disease it should be considered as a screening test.

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