Assessment of Agreement between Pretest Probability Score and Summed Stress Score of Myocardial Perfusion Imaging in Coronary Artery Disease

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ABSTRACT

Objective: **Cardiovascular diseases are considered an important cause of mortality & morbidity in many developing countries including Bangladesh. The first step in evaluating a patient with Coronary Artery Disease (CAD) is the clinical assessment of pretest probability. American Heart Association/ American College of Cardiology (AHA/ACC) guidelines recommend the use of Diamond and Forrester Method (DFM) or Duke Clinical Score (DCS) for calculating Pretest Probability Score (PPS). Myocardial Perfusion imaging (MPI) can calculate the Summed Stress Score (SSS), an index obtained by adding the individual scores derived from the 17 segments. This study was performed to assess the agreement between the established PPS with SSS so that it can help in risk stratification.**

Patients and Methods: **This cross-sectional observational study was carried out in National Institute of Nuclear Medicine & Allied Science (NINMAS), BSMMU from July 2016 to June 2017. A total of 89 suspected or known CAD patients were included in this study. PPS was calculated by Duke clinical scoring from brief clinical history. SSS was calculated by nuclear medicine software while performing MPI. Statistical analyses was carried out by using the IBM Statistical Package for Social Sciences (SPSS) version 20.0.0 (IBM Corporation Software Group Somers, NY). Pearson correlation and Bland & Altman analyses were applied for assessing correlation and agreement between PPS and SSS. Degree of relation between variables is expressed by 'r' (Pearson's correlation coefficient).**

Results: **The mean of PPS was found 14.73 ± 3.35 and that of SSS was found 16 ± 14.01. A positive correlation (r=0.108; p=0.312) between PPS and SSS. With Bland and Altman analysis, it was observed that mean difference of PPS and SSS was -1.27 ± 14.045. The limit of agreement ranged from -28.798 to 26.259. There was a positive correlation between PPS and SSS. Mean difference between the two scores was small. The bias between the scores was not significant. The differences within mean ± 1.96 SD were not statistically significant.**

Conclusion: **This study shows PPS and SSS can be used interchangeably. This analysis of agreement between PPS and SSS can further enhance prediction of CAD and upgrade the utilization of SSS for risk stratification in CAD patients, which will influence therapeutic management of the patients and play a major role to reduce cardiovascular mortality and morbidity.**

Keywords: **Pretest Probability Score, Summed Stress Score, Myocardial Perfusion Imaging, Coronary Artery Disease.**

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INTRODUCTION

Coronary Artery Disease (CAD) is the leading cause of death worldwide (1). CAD, also known as Ischemic Heart Disease (IHD), is a group of diseases that includes: stable angina, unstable angina, myocardial infarction, and sudden cardiac death (2). The age adjusted death rate is 53.53 per 100,000 of population and ranks Bangladesh at number 150 in the world (3).

National and international guidelines on the investigation of stable CAD have given increasing importance to the pretest probability for the presence of CAD, provided risk scores and recommended the optimal investigation for the different risk score categories (4). One can estimate the pretest probability for CAD in a chest pain patient based on the patient's age, sex, and pain characteristics, known as Diamond & Forrester method (DFM) (5). Another method is Duke Clinical Score (DCS) which considers patient's sex, age, type of chest pain, smoking, diabetes mellitus, dyslipidemia, family history of CAD and obesity (6). AHA/ACC guidelines recommend the use of DF or DCS. Pretest score: Low 0 to 8 points; Intermediate 9 to 15 points; High > 15 points (7).

MPI performed with gated single-photon emission computed tomography (SPECT) are analyzed not only visually but also by a number of semiquantitative measures performed by the various computer programs used for imaging. Some of the important

semiquantitative measures include Summed Stress Score (SSS), Summed Rest Score (SRS), and Summed Difference Score (SDS).The SSS, SRS, and SDS incorporate the extent and severity of perfusion defects during stress and rest. The SSS is an index obtained by adding the individual scores derived from the 17 segments that are analyzed and scored during a stress study. Each segment is scored on a 5-point scale: 0 = normal, 1 = mild reduction of tracer uptake (equivocal), 2 = moderate reduction of uptake (usually implies a significant abnormality), 3 = severe reduction of uptake, 4 = absence of uptake (8).

PATIENTS AND METHODS

A total of 89 patients with suspected or known CAD attending the National Institute of Nuclear Medicine & Allied Science (NINMAS) from July 2016 to June 2017 were enrolled in this study. All underwent stress-rest MPI with ^{99m}Tc-sestamibi. SPECT acquisition with ECG gating at rest phase was done 45-60 minutes after injection of 25 mCi tracer on the same day following the post-stress scan (done 15-30 minutes after stress injection of 10 mCi of tracer). Acquisition image was done with the double-headed SPECT scintillation camera with detectors 76° to each other. Low Energy All Purpose (LEAP) collimators with parallel holes were used with 1.45 zoom. A symmetric 15% energy window around the 140 keV ^{99m}Tc photo-peak was set. Data was stored in 64X64 matrices (pixel size 6.59cmm, 21-27 slices in short axis).ECG gating was done with three limb leads and acquisition was set to eight frames per R-R interval (about 153 ms/frame). Patients with history of cardiogenic shock, unstable angina, unorganized thrombus in left ventricular cavity, left ventricular failure, acute myocardial infarction, pregnant and lactating mother were excluded. The participants were briefed about the details of the study procedure and radioisotope was administered maintaining internationally recommended safe procedures. MPI was done by Symbia Evo Excel dual head gamma camera. SSS was automatically generated by the software while performing MPI.

For quantitative assessment of LVEF, EDV & ESV, 4D-MSPECT v4.2 software (Invia, LLC 2007) provided by Siemens medical solutions, Inc and Toshiba Corporation was applied to process & interprete raw GSMPI images. Perfusion data, semi quantitative scores (SSS, SRS, SDS), measurement of LV volumes, LVEF and LV wall motion were obtained from GSMPI images. Statistical analysis of data was done using IBM SPSS version 20.0.0 (IBM Corporation Software Group Somers, NY) for windows. In SPSS, data were analyzed by two stages. For analysis of agreement between PPS and SSS, Bland-Altman plots were constructed.

RESULTS

The study included 89 patients (80 males, 9 females) with mean age 53.17 ± 10.5 years (range 25-81 years), mean height 1.67 ± 0.07 m, mean weight 69.95 ± 9.32 kg and mean BMI 25.12 ± 3.13 kg/m2. Majority of the patients had history of typical angina (typical angina: 55.1%, atypical angina: 23.6%, non-angina: 21.3%). majority of patients, (93.3%) were hypertensive, more than half (53.9%) had type II diabetes mellitus and 82% had dyslipidemia. 55.1% patients had positive family history of CAD and 41.6% subjects were current smoker. Mean PPS was found 14.73 ± 3.35 and mean SSS was 16 ± 14.01.

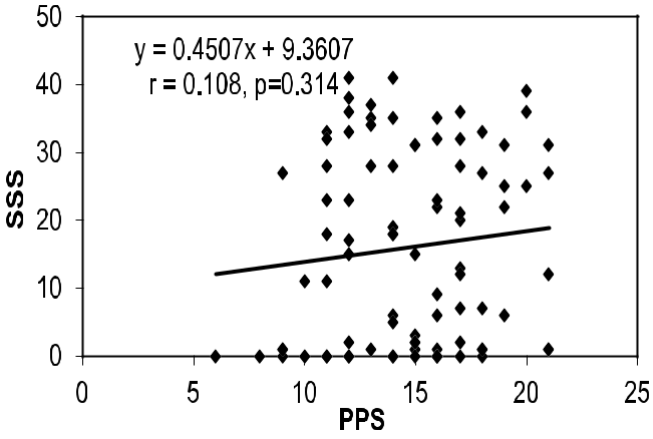

Figure 1: Scatter diagram showing positive correlation (r= 0.108; p= 0.312) between PPS and SSS.

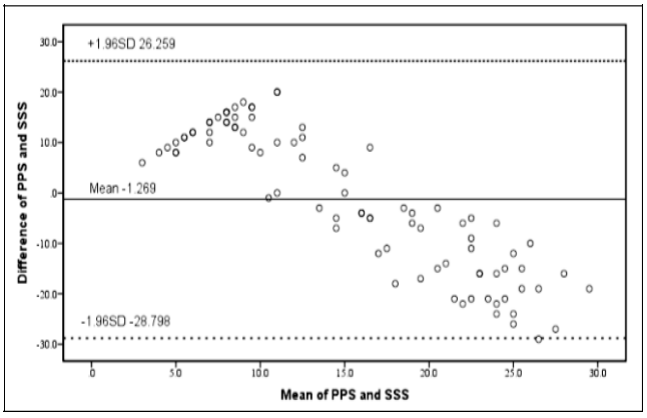

Figure 2 : Bland – Altman plot of PPS versus SSS showing good agreement between the groups.

There was a positive correlation (r = 0.108; p = 0.312) between PPS and SSS (Figure 1). According to the Bland-Altman plot, mean difference of PPS and SSS was -1.27 ± 14.045. 95% of differences were found in between -28.798 and 26.259 (Figure 2).

DISCUSSION

It was observed that majority (38.2%) of patients belonged to 51-60 years and mean age was found 53.17 ± 10.5 years. Bittencourt et. al. found the mean age 56 ± 13 years, which closely resembles with the present study. It was observed that almost ninety (89.9%) patients were male and 10.1% patients were female and male female ratio was 9:1. Bittencourt et al. and Genders et al. found 57% and 68.9% being male respectively (9,10), which also closely resembles with the present study. Similar observation regarding the male predominance was also observed by Schenker et al. (11).

In this current study, mean BMI was observed 25.12 ± 3.13 kg/m^2 which ranged from 17.3 to 41.9 kg /m^2. Schenker et al. found higher BMI 31.9 ± 8.7 kg/m^2, than the current study and western structure and higher body surface area might explain this. History of angina was observed in more than half (55.10) of the patients and among them 23.6% had atypical angina and 21.3% had no history of angina. Schenker et al. Found 25.4% atypical angina, 20.6% patients had typical angina nad 52.0% had no history of angina (11).

The traditional risk factors for CAD are high LDL cholesterol, low HDL cholesterol, high blood pressure, family history, diabetes, smoking and being post-menopausal for women and obesity can also be a risk factor (12). In this study, it was observed that most (93.3%) of the patients had hypertension, 82.0% patients had dyslipidemia, 55.1% had positive family history of CAD, 53.9% diabetes mellitus (DM) and 41.6% patients were smoker. Schenker et al. reported hypertension in 79.3% and diabetes mellitus in 34.6%, positive family history of CAD 34.6% and smoking in 18.4% (11). Bhattacharyya et al. reported that traditional cardiovascular risk factors such as progressing age, diabetes mellitus, hypertension, dyslipidemia, smoking, and obesity are well-accepted for their relationship with CAD (12). Smokers have an increased risk of heart attack, depending on the number of cigarettes smoked daily and the number of years they have smoked (13). More than half of the patients suffering from diabetes mellitus die from CAD; moreover, DM patients have increased risk of developing CAD compared to patients not having DM (14).

Imamura et al. reported that the SSS was the most powerful independent predictor of all ischemic cardiac events (hazard ratio 1.1, CI 1.05 - 1.11). Abnormal SSS (>4) was associated with a significantly higher cardiac event rate in patients with an intermediate to high pretest probability of CAD. Segmental perfusion scores, especially SSS, were related to a significant increase in the risk for ischemic cardiac events.

In this study a positive correlation between PPS and SSS was found. With Bland and Altman analysis mean difference between the scores was small. The bias between the scores was not significant. The differences within mean ± 1.96 SD were not statistically significant. Hence PPS and SSS can be used interchangeably.

CONCLUSION

This analysis of agreement between PPS and SSS can further enhance prediction of CAD and upgrade the

utilization of SSS for risk stratification in CAD patients, which will influence therapeutic management of the patients and will play a major role to reduce cardiovascular mortality and morbidity.

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