fortune Journals

Research Article

CARDIOLOGY AND CARDIOVASCULAR MEDICINE

ISSN: 2572-9292

Post Systolic Motion – A Marker for Ischemia in Left Bundle Branch Block

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Abstract

Background: To diagnose ischemia in patients with left bundle branch block (LBBB) patients non-invasively is always a diagnostic challenge. Many of the non-invasive modalities like stress test, nuclear imaging, cardiac CT and MRI that are routinely used to detect ischemia in recent times have their own limitations when used in patients with LBBB. Tissue Doppler imaging (TDI) has shown promising results in detecting ischemia in LBBB patients in various studies.

Methods: The study population was divided into two groups. Group one included 22 patients with LBBB with left anterior descending artery (LAD) stenosis > 50%. Group two includes 29 patients with LBBB with no or < 50% LAD stenosis. Both groups were subjected to TDI.

Results: TDI showed low myocardial systolic velocities (Sm), high late diastolic velocities (Am) and high post-systolic motion (PSM) in patients with LAD stenosis. PSM > 6.3 m/s and Sm/ PSM ratio ≤ 0.8 detected LAD stenosis with 77% sensitivity and 96% specificity.

Conclusions: TDI may be useful to identify ischemia in patients with LBBB.

Keywords: LBBB; LAD Stenosis; Post-Systolic Motion (PSM).

Introduction

Left bundle branch block (LBBB) is usually considered pathological and indicative of coronary artery disease (CAD) in a resting ECG unless proved otherwise. But actually prevalence of CAD in patients with LBBB varies between 30-52% [1,2]. LBBB can also occur in non-ischemic conditions like aortic stenosis, dilated cardiomyopathy, hypertension and older age [3]. Non-invasive modalities commonly used to assess CAD are found to have several drawbacks and false positive results in patients with LBBB. Tissue Doppler imaging (TDI) identifies ischemia by exhibiting variations in myocardial tissue systolic and diastolic velocities. Studies have shown that myocardial systolic and diastolic velocities and post systolic motion measured by TDI can be used as an early marker to identify ischemia in patients with LBBB [4-8]. Since there is a paucity of data concerning the above parameters, we designed a prospective case control study to test whether the above parameters can be used as an early marker to identify ischemia in patients with LBBB.

S' – Peak systolic velocity, PSM – Post-systolic motion, E' – Peak velocity of early ventricular filling, A' – Peak velocity of atrial contraction.

Materials and Methods

We conducted a prospective case control study in Vinayaka mission medical college and research centre, Karaikal, between august 2020 to

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Citation: Praveen Babu R, Arun kumar S, Sakthivel V. Post Systolic Motion – A Marker for Ischemia in Left Bundle Branch Block. Cardiology and Cardiovascular Medicine 6 (2022): 456-460.

Received: August 03, 2022
Accepted: August 18, 2022
Published: September 20, 2022

Babu RP et al., Cardiol Cardiovasc Med 2022
DOI:10.26502/fccm.92920282

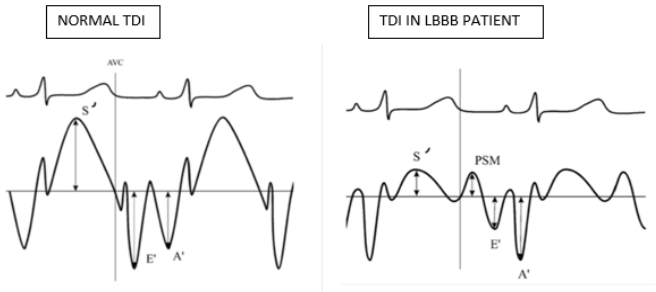

Figure 1: TDI in Normal and Abnormal.

July 2021. 51 patients who came to cardiac OP with LBBB and who had underwent coronary angiogram (CAG) were enrolled for the study. Patients were divided into two groups based on their CAG findings. Group one includes 22 patients, who had significant left anterior descending artery (LAD) stenosis > 50%. Group two includes 29 patients who had no LAD stenosis or ≤ 50% stenosis. Patients with valvular heart diseases, congenital heart diseases, pacemakers and abnormal A-V pathways were excluded from the study. Both groups were subjected to 2D Echo, Doppler echo and TDI using Esoate my Lab Gamma machine equipped with a phased array transducer. The following TDI measurements, myocardial systolic velocity (Sm), myocardial early diastolic velocity (Em), myocardial late diastolic velocity (Am) were measured. Statistical analyses was done using software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1.

Results

Table-1 shows that baseline characteristics are comparable between the groups. Though p value for heart rate was statistically significant, when considered clinically it is insignificant value falls within normal limits.

(IVS – interventricular septal thickness, PWT – posterior wall thickness, LVDD – left ventricular end diastolic diameter, LVSD – left ventricular end systolic diameter, EF – ejection fraction, LV mass – left ventricular mass, LVMI – left ventricular mass index)

Table- 2 shows the results of 2D – Echocardiographic M-mode analysis between the two groups. Patients with LAD stenosis had a significantly lower septal wall thickness (p=0.04) and posterior wall thickness (p=0.032) and a greater LV - end diastolic (p<0.001) and LV – end systolic dimensions (p=0.004).

(E – early diastolic filling velocity, A- atrial filling velocity, DT – deceleration time and IVRT- iso-volumic relaxation time)

Table- 3 shows the results of Echo Doppler analysis. Patient with LAD stenosis showed a mild reduction in iso-volumic relaxation time when compared to other group. No differences were found in other variables between the two groups.

(Sm - myocardial systolic velocity, Em - myocardial early diastolic velocity, Am - myocardial late diastolic velocity and PSM – post systolic motion)

Table- 4 shows the results of pulsed tissue doppler analysis of mid posterior interventricular septum. Patients with LAD stenosis had higher amplitude of PSM (p<0.001), lower Sm peak velocity (p<0.001) and higher Em and Am peak velocities when compared to patients without LAD stenosis. Both Sm/PSM ratio and Em/Am ratio were significantly

Table 1: Baseline Characteristics of Study Population.

Baseline characteristics	Group I (With LAD stenosis)	Group II (Without LAD stenosis)	P value
Age	60.77 ± 8.45	59.55 ± 7.53	0.59
Gender • Male • Female	 15 7	 21 8	0.743
Hypertension	16	22	0.799
Diabetes mellitus	12	14	0.657
Dyslipidemia	13	15	0.692
Family history of CAD	7	10	0.842
Body mass index	26.39 ± 2.76	25.47 ± 2.36	0.208
Body surface area	1.85 ± 0.16	1.79 ± 0.21	0.233
Systolic BP (mm HG)	130.64 ± 12.79	129.66 ± 13.63	0.79
Diastolic BP (mm HG)	79.82 ± 8.57	81.24 ± 7.99	0.544
Heart rate (beats/min)	70.27 ± 7.57	76 ± 8.4	0.15*

Babu RP et al., Cardiol Cardiovasc Med 2022
DOI:10.26502/fccm.92920282

lower in patients with LAD stenosis group compared to the other.

(Sm - myocardial systolic velocity, Em - myocardial early diastolic velocity, Am - myocardial late diastolic velocity and PSM – post systolic motion)

Table- 5 shows the results of pulsed tissue doppler analysis at lateral mitral annulus. Patients with LAD stenosis had lower Am peak velocity ($p<0.001$) and higher Em/Am ratio compared to patients without LAD stenosis.

The ideal cut – off values of PSM, Em/Am ratio and Sm/PSM to predict LAD stenosis were >0.63, ≤0.73 and ≤0.81. The positive likelihood ratios of PSM and Sm/PSM ratio variables were higher than other variables and the negative likelihood ratios of PSM and Sm/PSM variables were lower

Table 2: Echo M-MODE Analysis.

Echo M-MODE	Group I (With LAD stenosis)	Group II (Without LAD stenosis)	P value
IVS (mm)	9.45 ± 1.34	10.93 ± 2	0.004**
PWT (mm)	9.55 ± 1.22	10.52 ± 1.77	0.032*
LVDD (mm)	56.14 ± 3.77	51.24 ± 4.16	< 0.001**
LVSD (mm)	40.45 ± 3.33	37.17 ± 4.18	0.004**
EF (%)	55.64 ± 5.85	55.1 ± 5.7	0.745
LV MASS (g)	207.36±36.17	210.38±48.83	0.809
LVMI (g/m²)	111.50±23.66	116.66±24.6	0.455

Table 3: Echo Doppler Analysis.

Echo Doppler	Group I (With LAD stenosis)	Group II (Without LAD stenosis)	P value
E (m/s)	55.55±5.79	55.10±6.75	0.807
A (m/s)	52.95±6.98	57.00±9.21	0.092
E/A	1.06±0.11	0.99±0.23	0.247
DT (ms)	200.18±17.51	197.45±27.85	0.688
IVRT (ms)	89.59±11.28	97.14±13.23	0.037*

Table 4: Tissue Doppler Imaging - MID Posterior Inter Ventricular Septum.

Tissue Doppler Imaging - MID Inter Ventricular Septum	Group I (With LAD stenosis)	Group II (Without LAD stenosis)	P value
Sm (cm/s)	4.68±0.71	6.70±1.02	<0.001**
Em (cm/s)	6.89±0.99	6.17±1.02	0.015*
Am (cm/s)	9.85±1.06	7.89±1.16	<0.001**
PSM (cm/s)	8.66±2.43	4.71±1.09	<0.001**
Em/Am ratio	0.70±0.04	0.78±0.08	<0.001**
Sm/PSM ratio	0.62±0.29	1.52±0.48	<0.001**

Table 5: Tissue Doppler Imaging - Lateral Mitral Annulus.

Tissue Doppler Imaging - Lateral Mitral Annulus	Group I (With LAD stenosis)	Group II (Without LAD stenosis)	P value
Sm (cm/s)	7.88±0.94	7.94±0.86	0.825
Em (cm/s)	8.40±1.35	8.60±1.23	0.592
Am (cm/s)	9.47±1.32	11.74±1.12	<0.001**
Em/Am ratio	0.89±0.03	0.73±0.04	<0.001**

Table 6: ROC curve analysis to predict LAD stenosis in patients with LBBB using PSM, Em/Am ratio and Sm/PSM ratio.

	Cut-off score	AUC	P value	Sensitivity	Specificity	LR+	LR-
PSM (cm/s)	>6.3	0.908	<0.001**	77.27	96.55	22.41	0.24
Em/Am RATIO	≤0.73	0.847	<0.001**	86.36	75.86	3.58	0.28
Sm/PSM RATIO	≤0.81	0.936	<0.001**	77.27	96.55	22.41	0.24

Babu RP et al., Cardiol Cardiovasc Med 2022
DOI:10.26502/fccm.92920282

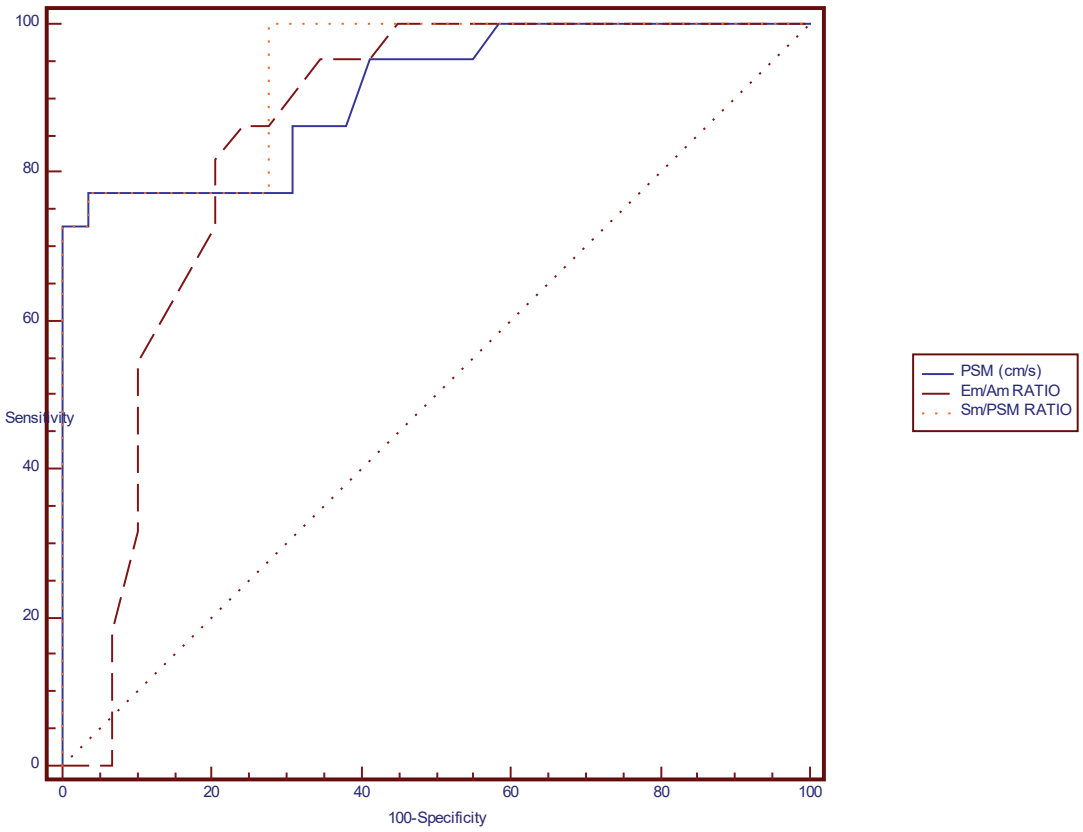

Figure 2: ROC curve analysis to predict LAD stenosis in patients with LBBB using PSM, Em/Am ratio and Sm/PSM ratio.

than other variables. An Sm/PSM ratio of ≤0.81 was found in 77% of patients with LAD stenosis and only 3% of patients without LAD stenosis with a sensitivity of 77%, specificity of 96%, positive predictive value of 94% and negative predictive value of 85%.

Discussion

PSM is a delayed ejection motion of myocardium occurring in iso-volumic relaxation time (IVRT) about 100 milli seconds after aortic valve closure. Gibson et al, first described PSM by cine-ventriculograms 4-hours post myocardial infraction [9]. PSM is an early and sensitive marker of ischemia [10,11]. PSM is seen in akinetic, hypokinetic and dyskinetic segments. But the mechanism of PSM slightly varies among these segments. In dyskinetic segments, PSM is due to passive inward movements caused by adjacent normally contracting segments. In hypokinetic segments, it is due to delayed active contraction appearing after LV unloading and decrease in regional wall stress [12]. PSM can also be seen in non-ischemic myocardium i.e. in patients free of CAD, such as LVH, LV volume overload and even in healthy subjects [13,14,15]. In our study also PSM is seen not only in patients with LBBB with LAD stenosis but also in patients with LBBB without LAD stenosis. So, when we analyze the differences, PSM occurring in patients with LAD stenosis is of higher amplitude, delayed (> 100ms from aortic valve closure) and associated with reduced myocardial systolic velocities. In our study, PSM value of > 6.3 m/s was found in 77% of LBBB patients with LAD stenosis and 3% in patients without LAD stenosis. So when we set of a cut-off value for PSM >6.3 m/s, it had 77% sensitivity and 96% specificity in detecting LBBB patients with LAD stenosis. Systolic phase and early diastolic relaxation phases of cardiac cycle are high energy consuming processes and are very sensitive to ischemia. So systolic (Sm) and early diastolic (Em) myocardial velocities are reduced in patients with ischemia [16,17,18,19]. Similarly late diastolic phase of cardiac cycle is relatively passive and less energy consuming compared to the above phases. Late diastolic (Am) myocardial velocities are increased in patients with ischemia [20]. In our study also Em/Am ratio is reversed in LBBB patients with ischemia. In this study, Sm/Psm ratio < 0.8 LAD stenosis in LBBB patients with 77% sensitivity and 96% specificity and negative predictive value of 85%. Similar results were obtained by Citro et al, in his study [21]. Limitations of the present study was that the TDI sampling was limited to IVS and LV lateral mitral annulus assuming dyskinesia due to LBBB is predominantly evident at the septal level. The study, would have been more comprehensive if we had evaluated other LV segments also. Another limitation is that in clinical

setting, measurement of PSM needs patience, technical feasibility and additional time to acquire and interpret during routine echo evaluation.

Conclusions

Evidence of CAD in LBBB patients is difficult to unmask using traditionally non-invasive tools. Present study demonstrate the use of TDI to identify CAD in LBBB patients. PSM value of > 6.3 m/s and Sm/PSM ratio ≤ 0.8 detects ischemia in LBBB patients with high sensitivity and specificity. So, TDI can be used as a routine non-invasive tool to assess ischemia in LBBB patients.

Conflict of interest

Authors have no conflict of interest.

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