Original Article

Measurement of Coronary Sinus Blood Flow after First Anterior Myocardial Infarction with Transthoracic Echocardiography and its Correlation with Wall Motion Scoring Index

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ABSTRACT

Objectives: The aim of this study was measurment of Coronary Sinus Blood Flow (CSBF) and Coronary Sinus Velocity time Integral (CSVTI) via transthoracic echocardiography (TTE) in patients with acute myocardial infarction (AMI) in association with left ventricular ejection fraction (LVEF), wall motion scoring index (WMSI) and in-hospital mortality.

Material and Methods: Twenty patients with anterior AMI and 20 healthy individuals as controls, were studied in 6 months period in 2005 in Madani Heart Center in Tabriz, Iran. All received same drugs for AMI treatment (e.g. fibrinolytic). CSBF, CSVTI, WMSI and tissue Doppler imaging (TDI) data were obtained via TTE and compared between the two groups.

Results: Baseline variables were similar between two groups (p>0.05). CSBF in AMI group was 287.8 ± 128 ml/min and 415 ± 127 ml/min in control group (p=0.001). CSVTI was significantly lower in AMI group than control group (11.16 ± 2.85 and 17.56 ± 2.72 mm, respectively; p = 0.003). There was significant correlation between CSBF and LVEF (r = 0.52, p= 0.01), WMSI (r = -0.77, p = 0.0001) and in-hospital mortality (r=0.58 p= 0.03), also between CSVTI and LVEF (r = 0.85, p = 0.0001), WMSI (r = -0.57, p = 0.0009) and in hospital-mortality rate (r = 0.69, p = 0.02). CSBF and CSVTI had good correlation with TDI findings: Em (peak early diastolic velocity in the myocardium) and Sm (peak systolic velocity in the myocardium).

Conclusion: Our study demonstrated good correlation between measured CSBF and CSVTI by 2D, Doppler TTE and LVEF, WMSI, in-hospital mortality and also TDI findings; also we found that CSBF and CSVTI were independent predictors in AMI patients. (Rawal Med J 2007;32:112-117).

Key words: Myocardial infarction, transthoracic, echocardiography, oronary sinus, wall motion scoring index, tissue doppler imaging.

INTRODUCTION

Coronary sinus blood flow (CSBF) is often used as a measure of cardiac perfusion. However, the standard techniques for measurement of cardiac perfusion are invasive and require cardiac catheterization (intravascular Doppler flow wire, thermodilution catheter, or digital coronary angiography) or the use of radioisotope dyes (argon technique or xenon scintigraphy).[1]

Pervious studies described the use of transesophageal echocardiography (TEE) in the measurement of CSBF and coronary flow reserve and demonstrated the feasibility and reproducibility of TEE in measuring coronary sinus flow. In contrast to TEE, transthoracic echocardiography, (TTE) with Doppler flow measurement provides a noninvasive means of measuring CSBF. By using this noninvasive method, a statistically significant increase in coronary artery flow after revascularization procedures has been shown.[1]

The aim of this study was to measure CSBF and coronary sinus velocity time integral (CSVTI) via TTE in patients with acute myocardial infarction (AMI) and its relation with left ventricular ejection fraction (LVEF), wall motion scoring index (WMSI) and in hospital mortality.

METHODS

Twenty patients with anterior MI and 20 healthy individuals as controls were studied in 6 months period in 2005 at Madani Heart Center in Tabriz, Iran. All patients received same drugs for AMI treatment (e.g. fibrinolytic). CSBF, CSVTI, WMSI and tissue doppler imaging (TDI) data were obtained via TTE and compared between the two groups.

Echocardiographic study was performed with a 2.5 MHZ transducer of commercially available equipment (VIVID7, GE, USA). Coronary sinus (CS) diameter measured in posterior angulated four-chamber view, its flow obtained in right ventricular (RV) inflow view with optimize zooming and placing of pulse wave sample volume (PWSV) in its orifice to record its flow. CSBF was identified by systolic and diastolic signals with very little respiratory variation (in contrast to inferior vena cava flow). (Fig 1 and 2).

Figure 1. Biphasic doppler flow pattern recording in a coronary sinus characterized by systolic and diastolic anterograde flows. D= diastolic flow; S= systolic flow.

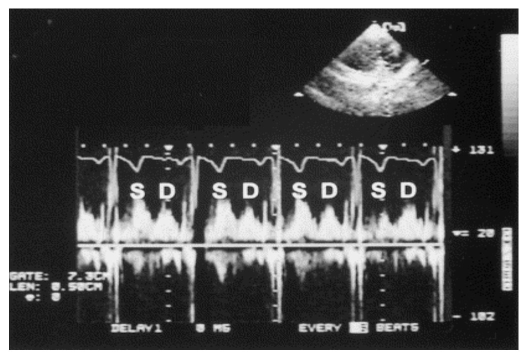
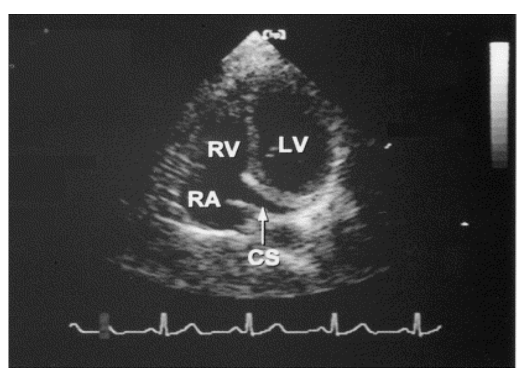


Figure 2. Modified apical four-chamber view demonstrating clear visualization of the CS with posterior tilting of the transducer. CS= coronary sinus; LV= left ventricle; RA= right atrium; RV= right ventricle



The CSVTI was measured by outlining the flow velocity signal and using a computer algorithm in the ultrasound machine. The CS was then imaged in the apical four-chamber view of the CS, with posterior tilting of the transducer (Figure 2).

Diameters of the coronary sinus taken at five equally spaced segments in the cadiac cycle, over three cardiac cyles, were averaged and used as the major diameter of the CS. Assuming that the cross section of the CS is an ellipse and that the major diameter is double the length of the minor diameter, the cross – sectional area of the CS was calculated as: [0.39 × (the major diameter)]. CSBF was then calculated as: [(CSVTI) × (cross-sectional area of the CS) × (heart rate)].

All study continuous parameters are expressed as mean and standard deviation. Comparisons between continuous variables recorded from Control and AMI groups were made with the independent samples t-test. Categorical variables between the two groups were analyzed by Chi-square or Fisher exact tests as appropriate. Statistical significance was accepted $p<0.05$. Data analysis was performed using SPSS ver 13 software.

RESULTS

Baseline variables were similar between two study groups (table 1).

Table 1. Baseline characteristics in patients in two study groups

Group / variable	Acute myocardial infarction (n=20)	Control group (n=20)	P
Age (year)	53.8 ± 12.4*	47.9 ± 12.3	0.136
Sex (male/female)	15/5	14/6	1.000
Hight (cm)	168 ± 10	167 ± 9	0.784
Weight (kg)	77 ± 15	72±12	0.272
BMI **	27.1±3.9	25.8±3.6	0.284
LVEF ***	0.39 ± 7%	0.58±4%	0.0001
Familial history	1(5%)	1(5%)	1.000
Smoking	8(40%)	4(20%)	0.271
Deslipidemia	9(45%)	7(35%)	0.748
Hypertension	9(45%)	4(20%)	0.177
Diabetes Mellitus	3(15%)	2(10%)	1.000
Coronary sinus diameter	0.88 ± 0.15	0.83 ± 0.17	0.12
Heart rate	80 ± 10	73 ±12	0.1

* Values are shown as mean ± SD or number (%)

** BMI = Body Mass Index

*** LVEF:Left Ventricular Ejection Fraction

The CS was visualized in all 20 AMI pts and 20 controls with adequate samples of CS flow velocity. All pts were in sinus rhythm.

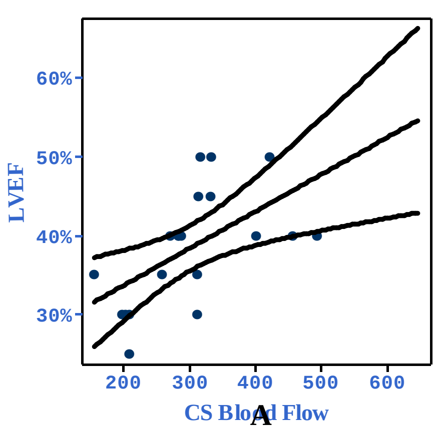
VTI in AMI group was significantly lower than Control group (11.16± 2.85 cm vs. 17.56 ± 2.72 cm respectively; p= 0.003). CSBF in AMI group was 287.8 ± 128 ml/min while in Control group was 415 ± 127 ml/min (p=0.001; Table2).

Table 2. Comparison of coronary sinus parameters between the two groups

Group / variable	Acute myocardial infarction (n=20)	Control group (n=20)	P
CSBF* (ml/min)	287.8 ± 128	415 ± 127	0.001
CSVTI** (cm)	11.16 ± 2.85	17.56 ± 2.72	0.003
*CSBF= Coronary Sinus Blood Flow **CSVTI: Coronary Sinus Velocity Time Integral			

Figure 3 shows correlations between CSBF and LVEF (r = 0.52, p=0.01), WMSI (r=-0.77, p= 0.0001) and in-hospital mortality (r=0.58, p= 0.03). Also there was relatively high correlation between CSVTI and LVEF (r=0.85, p= 0.0001), WMSI (r= -0.57, p= 0.009) and in-hospital mortality rate(r= 0.69, p= 0.02; Figure 4).

CSBF and CSVTI had positive correlation with TDI findings; Em (peak early diastolic velocity in the myocardium) and Sm (peak systolic velocity in the myocardium). Linear regression analysis (Figure 5) showed moderate but statistically significant correlation between CSBF and Em (r=0.47; p=0.037), and with Sm (r=0.47; p= 0.038). Also there was similar correlation between CSVTI and Em (r= 0.53; p=0.02), and with Sm (r= 0.46; p=0.042).



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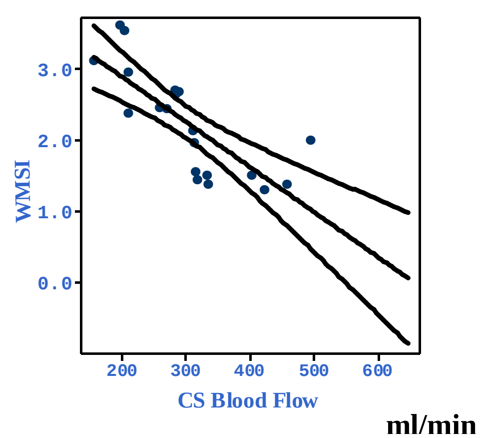
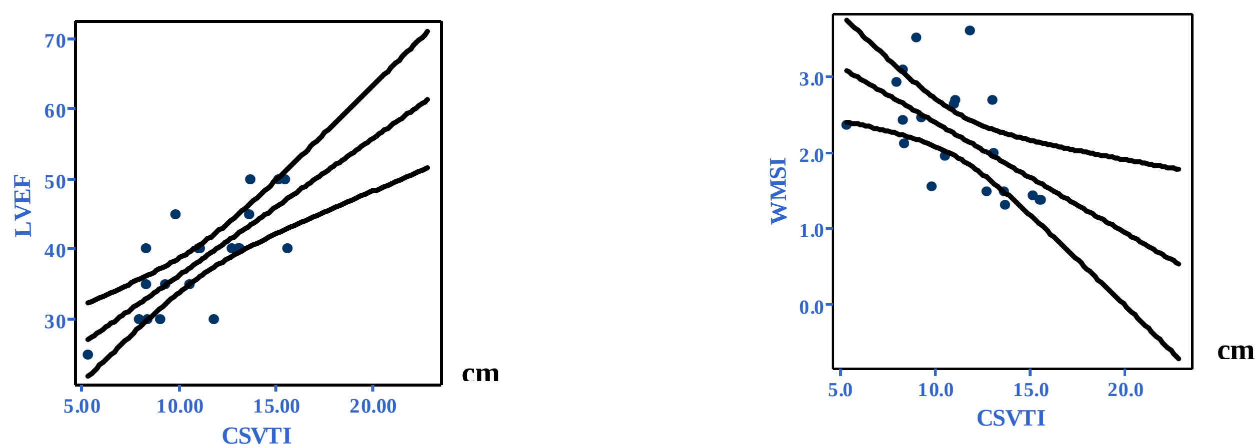


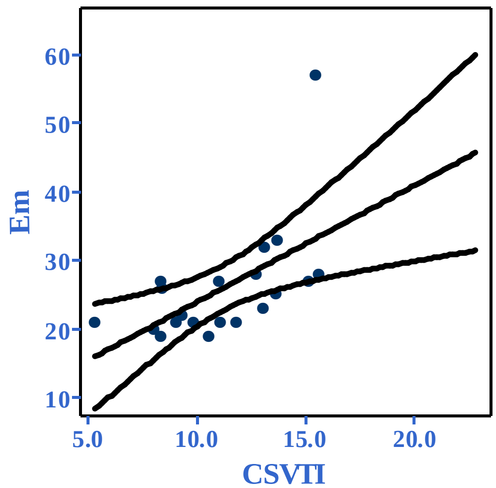
B

Fig 3. Linear regression between coronary sinus (CS) blood flow and left ventricular ejection fraction (LVEF; plot A), and wall motion scoring index (WMSI; plot B) in patients with acute myocardial infarction.
The lines in scatter plots indicate regression line and 95% mean prediction interval.



A **B**

Fig 4. Linear regression between coronary sinus velocity-time integral (CSVTI) and left ventricular ejection fraction (LVEF; plot A), and wall motion scoring index (WMSI; plot B) in patients with acute myocardial infarction.
The lines in scatter plots indicate regression line and 95% mean prediction interval.



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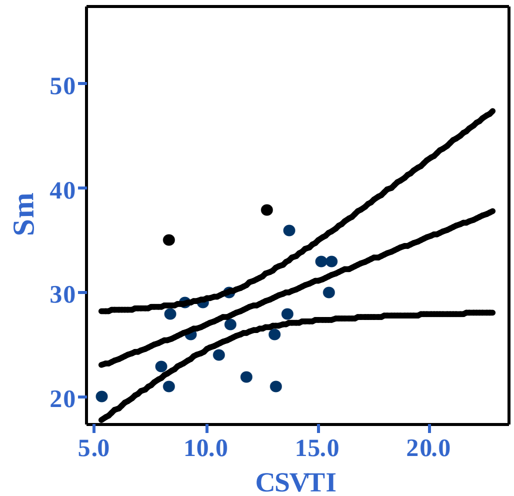

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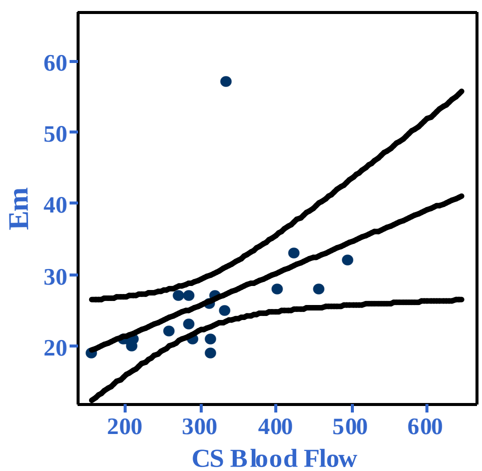

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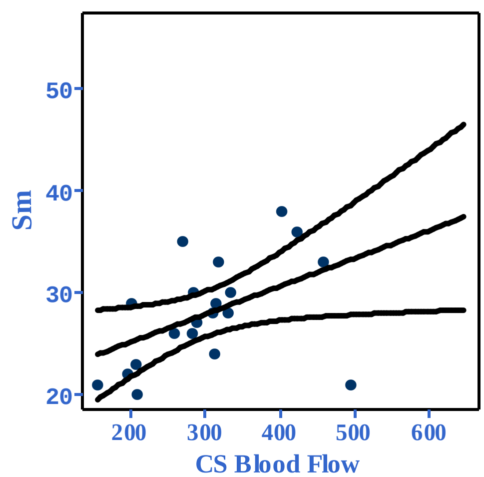

D

Fig 5. Scatter plots of linear regression among coronary sinus (CS) velocity-time integral (CSVTI; plots A & B) and blood flow (plots C & D), with pulsed TDI velocities (Em and Sm) in patients with acute myocardial infarction.
Em: Mean of peak early diastolic velocity in the myocardium (cm/sec).
Sm: Mean of peak systolic velocity in the myocardium (cm/sec).
The lines in scatter plots indicate regression line and 95% mean prediction interval.
Units: CSVTI= cm; CS blood flow= ml/min

DISCUSSION

Several studies have demonstrated that AMI produces remarkable decrease in CSBF. However, an objective measurement of CSBF has traditionally required invasive studies.[1-3] Terekhov[4] assessed CSBF in 42 patients using continuous thermodilution techniqe in the presence of thrombolytic treatment. Coronary venous flow was shown to increase by 20% and more in 17 pts, more than 30% in 15 patients, and more than 40% in 10. Inferior wall MI was associated with a significant increase of blood flow rate in the CS as well as other cardiac veins, while anterior MI was associated with flow rate increase in the CS only. A 20-30% increase in any of the coronary flow parameters limited the necrosis as evidenced by pericardial mapping.

Continuous CS thermodilution has shown that patients with anterior MI had a significantly less blood flow in the vena cordis magna than those with posterolateral infarction.[2] Other techniques used for measurement of CSBF have been CS myocardial clearance technique (Fick), positron emission tomography, MRI, radionuclide imaging and recently TEE but all of them are invasive or expensive.[5-7]

Another study showed that global myocardial blood flow and global flow reserve measurements by MRI and PET are comparable.[6]

Digital radiographic technique during cardiac catheterization to measure coronary flow before and after revascularization procedures have been used to demonstrate an elevated homodynamic state, implying an increased coronary blood flow.[8] CS flow velocity by pulse-doppler TEE during coronary artery bypass graft (CABG) surgery have been measured.[9] The peak velocity and VTI of CS blood flow in the post –CPB period increased significantly compared with in the pre-CPB period by CABG. The results of this preliminary study show the feasibility of clinical evaluation of CABG intraoperatively.

A strong association between CSBF measured by TEE and coronary sinus catheterism has been shown.[10] Using xenon -133 scintigraphy, Goldman et al.[11] measured blood flow before and after bypass surgery involving the left anterior descending vessels and found that the blood flow normalized after CABG, with blood flow at rest in the bypassed arteries being very similar to that measured in normal coronary vessels. In patients with aortocoronary bypass surgery, CSBF was found higher after than before surgery.[12] Thallium-201 uptake and washout in thallium-201 scintigraphy improved after CABG and that CSBF during pacing improved after CABG.[13]

By using noninvasive method of TTE for measuring CSBF we were able to show a statistically significant decrease in coronary artery flow after AMI, a finding previously established by invasive studies. Our data showed a decrease in CSBF and CSVTI in AMI group. In general, the decrease in CSBF was not related to the initial flow and was in the range of 100 to 200 ml/min. Differences in heart rates between AMI and Control groups were not statistically significant (table 1). Also, we found that CSBF & CSVTI had good correlation with LVEF, WMSI and in hospital mortality. Demonstration of the correlation between CSBF and CSVTI with TDI findings (Em & Sm) was very important and, it is a new finding.

One limitation of this study is that we were not able to compare our data with those of an invasive technique, but our results correlated well with those invasive studies by demonstrating the decrease in CSBF and CSVTI after AMI.

In conclusion, our study has demonstrated that TTE can be used to measure CSBF in patients with AMI. Also, our study demonstrated that CSBF and CSVTI were independent predictors of outcomes in AMI patients.

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