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Research Brief

Diagnostic accuracy of a novel 'winking coronary angiographic sign' in patients presenting with ventricular septal rupture complicating acute myocardial infarction

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ABSTRACT

Ventricular septal rupture (VSR) is an uncommon but potentially lethal complication of acute myocardial infarction (MI). Its prompt recognition is essential to permit timely institution of corrective measures. The present study was undertaken to assess the diagnostic accuracy of a novel and unique angiographic sign, the 'winking coronary sign (WCS)', for recognizing post-MI VSR. The WCS is defined as partial transient occlusion of the infarct-related culprit artery overlying the site of VSR during ventricular systole with near normal filling in the diastole. A total of 56 patients with post-MI VSR (mean age 60.9 ± 9.9 years, 75% male) were compared with 73 age- and sex-matched acute MI patients without VSR. The extent of coronary artery disease was not different between the two groups, but higher number of patients in the VSR group had thrombolysis in MI grade 3 flow (57.1% vs 34.5%, P 0.01). The WCS was observed in 67.9% of the patients with VSR but in none of the patients without VSR ($p < 0.0001$), yielding a sensitivity of 67.9% and specificity of 100% for this sign for diagnosing underlying VSR. This demonstrates the potential utility of the WCS for diagnosing VSR in patients in whom the VSR has developed in the time frame between the echocardiography and angiography or has been missed during the initial clinical and/or echocardiographic evaluation.

1. Introduction

Ventricular septal rupture (VSR) is an uncommon but potentially lethal complication of acute myocardial infarction (MI). Its prompt recognition is essential to permit timely institution of corrective measures.[1–7] However, post-MI VSRs are often missed initially, due to a variety of reasons. Most of the VSRs manifest as hemodynamic instability, which is often mistakenly attributed to the progressive myocardial damage secondary to MI, unless the patients present with sudden, frank pulmonary edema. In addition, the urgency to proceed with coronary angiography and myocardial revascularization in the setting of MI with hemodynamic instability may not allow an opportunity to perform a repeat echocardiogram. Moreover, even during echocardiography, there is an inherent tendency to miss a VSR unless specifically looked for by a careful, color Doppler interrogation of the entire ventricular septum.

In a previous pilot case series involving a small number of subjects, we had reported a unique angiographic finding of post-MI VSR, the 'Winking Coronary Sign (WCS)', or 'Kamal Sharma's sign', defined as partial transient occlusion of the infarct-related culprit artery (IRA) overlying the site of VSR during ventricular systole with near normal filling in the diastole (Fig. 1, Video). We had reported it to be present in 80.4% of the patients having post-MI VSR.[9] However, as this was only a small case series with no control arm, the present study was undertaken to more accurately assess the prevalence of WCS in patients with post-MI VSR and to assess its diagnostic accuracy for this purpose.

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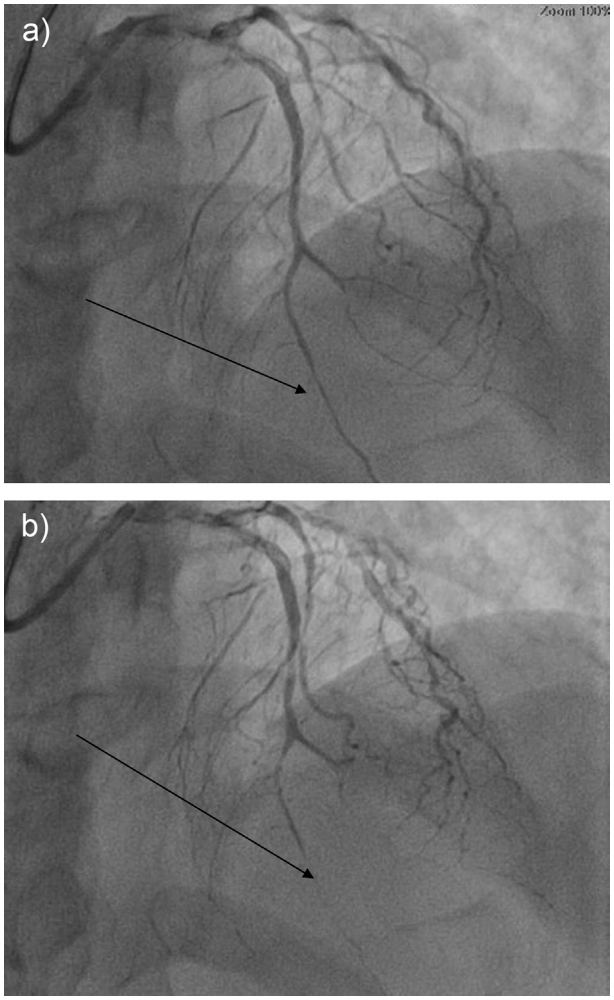

Fig. 1. a) PA(Postero-Adiastolenterior) cranial view of left anterior descending artery showing flowing artery in diastole. b) PA(Postero-anteriro)cranial systolic frame showing occluded LAD(left anterior descending) flow overlying the VSR in systole. VSR, ventricular septal rupture.

2. Methods

This was a retrospective, observer-blinded, case–control study involving 129 patients of which 56 cases were consecutive patients having VSR secondary to acute ST-segment elevation MI (STEMI), who had undergone cardiac catheterization between August 2008 and June 2017. These cases were compared with 73 age- and sex-matched control patients having STEMI without VSR, who were randomly picked from the database for the same study period. Demographic profile, echocardiographic and angiographic findings, and initial treatment modality offered were recorded for all the patients. The study was reviewed and approved by institutional ethics committee.

The diagnosis of STEMI was made as per the World Heart Organization definition.[8] The diagnosis of VSR was made on echocardiography. VSR was defined as disruption in the ventricular septum with evidence of left-to-right shunt by color Doppler. The location of the defect in the basal, mid, or distal septum was recorded.

2.1. Cardiac catheterization

Coronary angiography (CAG) was performed through standard femoral or radial artery approach. All the 56 patients with VSR had prior clinical and echocardiographic confirmation of VSR before undoing CAG and, therefore, underwent early CAG with or without placement of intra-aortic balloon pump. Obstructive coronary artery disease (CAD) was defined as any stenosis greater than 70% in any of the major epicardial arteries or greater than 50% stenosis in the left main coronary artery. The acute management of the CAD was determined by the overall clinical status of the patients and the distribution and the complexity of the coronary lesions.

2.2. Diagnosis of WCS

All the 129 coronary angiograms were reviewed and analyzed by three different interventional cardiologists who were trained to recognize WCS but were not aware of the presence or absence of VSR. WCS was considered to be present if confirmed by all three of them independently.

2.3. Statistical analysis

All statistical analyses were performed using SPSS v 20.0 (Chicago, IL, USA). Differences between the two groups were assessed using the chi-squared and Student's *t*-test for categorical and continuous variables, respectively. The diagnostic performance of WCS for post-MI VSR was presented as sensitivity, specificity, and positive predictive value with the corresponding 95% confidence intervals (CIs).

Table 1
Demographic, clinical, and angiographic details of the study patients.

Variables*	No VSR group ($n = 73$)	VSR group ($n = 56$)	*p*-value
Age, years	57.3 ± 9.8	60.9 ± 9.9	0.053
Male gender	62 (84.9)	42 (75)	0.117
Diabetes	5 (6.8)	14 (25)	<0.001
Hypertension	11 (15.7)	22 (39.3)	<0.001
CAD extent			0.219
Single-vessel disease	31 (42.5)	22 (39.3)	
Double-vessel disease	20 (27.4)	20 (35.7)	
Triple-vessel disease	22 (30.1)	14 (25.0)	
TIMI flow grade	22 (30.1)	9 (16.1)	0.01
TIMI grade 0	6 (8.2)		
TIMI grade 1	20 (27.4)	2 (3.6)	
TIMI grade 2	25 (34.4)	13 (23.2)	
TIMI grade 3		32 (57.1)	
Thrombolysis performed	29 (39.7)	17 (30.4)	0.16
WCS present	0 (0)	38 (67.9)	<0.0001

All values presented as actual numbers with percentages in parentheses, except age which is presented as mean ± standard deviation.
CAD, coronary artery disease; TIMI, thrombolysis in myocardial infarction; VSR, ventricular septal rupture; WCS, winking coronary sign.

Table 2
Diagnostic accuracy of WCS for recognizing VSR.

Statistics	Value	95% CI
Sensitivity	67.9%	54.0%–79.7%
Specificity	100.0%	95.1%–100.0%
Positive predictive value	100.0%	–

CI, confidence interval; VSR, ventricular septal rupture; WCS, winking coronary sign.

3. Results

The demographic, clinical, and angiographic details of the patients in the two groups are presented in Table 1. Mean age of the VSR patients was 60.9 ± 9.9 years, with three-fourths of them being male. Compared with the patients without VSR, those with VSR had higher prevalence of diabetes (25% vs 14.7%, $p < 0.001$) and hypertension (39.3% vs 15.7%, $p < 0.001$), but the extent of CAD was not different. Overall, single-vessel disease was the most common, followed by double-vessel disease and triple-vessel disease. However, thrombolysis in myocardial infarction (TIMI) flow grade was better in VSR patients (p value 0.01). Overall, 46 (36%) patients had undergone thrombolysis before CAG, with no difference between the two groups.

3.1. Diagnostic accuracy of WCS

WCS was observed in 67.9% of the patients with VSR, whereas none of the patients without VSR had WCS ($p < 0.0001$) (Table 1). This yielded a sensitivity of 67.9% (95% CI: 54.0%–79.7%) and specificity of 100% (95% CI: 95.1%–100%) for this sign for diagnosing underlying VSR (Table 2). The absence of WCS among patients without VSR resulted in a positive predictive value of 100%, although negative predictive value could not be calculated as the actual prevalence of VSR in STEMI patients could not be determined from this study.

4. Discussion

To the best of our knowledge, this is the first and only study reporting diagnostic value of a unique angiographic feature for post-MI VSR. We found that 'WCS', a highly specific sign of post-MI VSR, had a prevalence of 67.86% with sensitivity of 67.86% and specificity of 100%.

Our angiographic findings are strikingly different from the previous studies where total occlusion of the infarct-related artery was observed in post-MI VSR patients. The findings of a large study (GUSTO trial) showed that patients who develop VSR after acute MI are more likely to have total occlusion of the infarct artery.[7] In contrast to the GUSTO trial, majority of Asian Indian patients in this cohort had single-vessel disease (39.5%). Apart from WCS, we found that prevalence of diabetes and hypertension are important predictors of post-MI VSR in Asian Indians, which is in accordance with previous studies. In our study cohort, 25% and 39.3% of the post-MI VSR patients were suffering from diabetes and hypertension, respectively, which was similar to the findings of the Global Utilisation of Streptokinase and tissue Plasminogen activator for occluded arteries (GUSTO) trial.[7]

In contrast to previous reports,[10–12] our angiographic data suggest that those who develop VSR after acute MI are more likely to have partial occlusion of the infarct artery. According to Crenshaw et al,[7] majority (61%) of the post-MI VSR had either 0 or 1 TIMI grade flow, and only 39% had 2 or 3 TIMI grade flow, which is completely in contrast with our study, where TIMI grade flow 0 and 1 was found in 38% of the patients, and TIMI grade flow 3 and 4 was in 62%. The WCS has been postulated to happen due to the 'Venturi effect', 'mechanical theory', or 'hemodynamic theory'.[9] The Venturi effect could be due to the shunt across the VSR leading to a rapid drop in pressure across the defect causing overlying coronary artery to collapse manifesting as 'systolic winking' of the artery overlying the rupture. According to the mechanical theory, there is mechanical compression of the IRA due to instability of the septum adjacent to the rupture site.

The sensitivity and specificity assessment suggests that although this is relatively a smaller sample, significant statistical association makes this sign relevant to diagnose VSR especially with paucity of data on VSR in acute myocardial infarction (AMI) among Asian Indians.

5. Conclusion

This study demonstrates potential diagnostic utility of WCS, a novel angiographic sign, for recognizing underlying VSR in STEMI patients undergoing CAG. Thus, this sign can prove to be useful in alerting the interventionist about the possibility of VSR in patients in whom the VSR has developed in the time frame between the echocardiography and CAG or has been missed during the initial clinical and/or echocardiographic evaluation.

Conflicts of interest

All authors have none to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ihj.2018.11.010.

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