

Manifestation of Acute Coronary Syndrome in Critically Aortic Stenosis Patients

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Abstract

Case Report

The clinical presentation of acute coronary syndromes (ACS) is broad, from cardiac arrest, electrical or haemodynamic instability with cardiogenic shock (CS) due to ongoing ischaemia or mechanical complications such as severe mitral regurgitation, to patients who are already pain free again at the time of presentation. Critical aortic stenosis (AS) can cause inadequate myocardial perfusion and in the absence of demonstrable coronary stenosis or occlusion which resulting in ACS manifestation. Critical AS (defined as valve area <0.5 cm²) has been reported to cause mild increases in cardiac biomarkers such as troponin I. A 56-year-old man was admitted to hospital with chief complaint of typical chest pain. Electrocardiogram (ECG) shows myocardial infarction in left main (LM) equivalent. Echocardiography revealed critical aortic stenosis. Cardiac marker also shows increasing. However, diagnostic coronary angiography (DCA) did not identify any lesions to account for the patient's electrocardiographic changes and ongoing symptoms of chest pain. Consultation to cardiothorax surgeon to have urgent aortic valve replacement (AVR) were planned and underwent successful aortic valve (AV) replacement without coronary intervention. The definitive treatment for symptomatic severe AS is AVR. Some of the treatments that can be done are immediate coronary angiography and reperfusion procedure if there is suspicion of coronary artery occlusion or stenosis which may cause myocardial infarction; Intra-Aortic Ballon Pump (IABP) if there are signs of myocardial injury with take caution to the contraindications of IABP placement; Perform intervention procedure as soon as possible on aortic valve; Administration of medical therapy for heart failure in symptomatic severe AS patients. The case emphasizes the importance of initial physical examination, ECG, echocardiography, and cardiac markers as a whole that we do in aortic valve stenosis patient presenting with ACS.

Keywords: ACS, critical aortic stenosis, aortic valve replacement.

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INTRODUCTION

The clinical presentation of acute coronary syndrome (ACS) is broad. These range from cardiac arrest, electrical or hemodynamic instability with cardiogenic shock due to ongoing ischemia or mechanical complications such as severe mitral regurgitation, to patients who have no longer chest pain at the time of presentation. The main symptom that initiates the diagnostic and therapeutic course in a patient with suspected ACS is acute chest discomfort described as pain, pressure, tightness, and burning. Symptoms equivalent to chest pain may include dyspnea, epigastric pain, and pain in the left arm [1]. Acute myocardial infarction (AMI) defines necrosis of cardiomyocytes in a clinical setting consistent with acute myocardial ischemia[1].

However, not all cases of AMI are due to coronary artery occlusion or stenosis: critical aortic stenosis (AS) can lead to inadequate myocardial perfusion and in the absence of demonstrable coronary stenosis or occlusion. AS occurs in 2-9% of the general population over the age of 65, and its incidence increases with age. The risk factors for AS are similar to those of atherosclerosis (age, male gender, smoking, hypertension, and elevated lipoproteins and LDL)[2]. In patients with aortic valve stenosis, the development of left ventricular systolic dysfunction and heart failure predicts a poor prognosis, including poor outcome after valve replacement procedures. Severe symptomatic aortic stenosis is associated with a poor prognosis, with most patients dying within 2-3 years of diagnosis[3]. The onset of heart failure is preceded by structural and functional changes in the heart muscle with left ventricular hypertrophy followed by degeneration and death of cardiac myocytes[4]. Serum cardiac troponins I

and T are cardiac-specific contraction-regulating proteins that are released into the circulatory system from injured myocytes. The value of troponin in acute coronary syndromes is well known and troponin also assumes an evolving prognostic role in heart failure[5–7]. Critical aortic stenosis (defined as valve area <0.5 cm²) has been reported to cause mild elevations in cardiac biomarkers such as troponin I[8].

Case

A 56-year-old man was referred with chest pain typical of ACS. Electrocardiography (ECG) examination at the referral hospital showed a sinus tachycardia rhythm accompanied by multiple premature ventricular contractions (PVCs) with NSTEMI very high risk, characterized by ST-elevation in the AVR lead and ST-depression in the precordial lead (Figure 1).

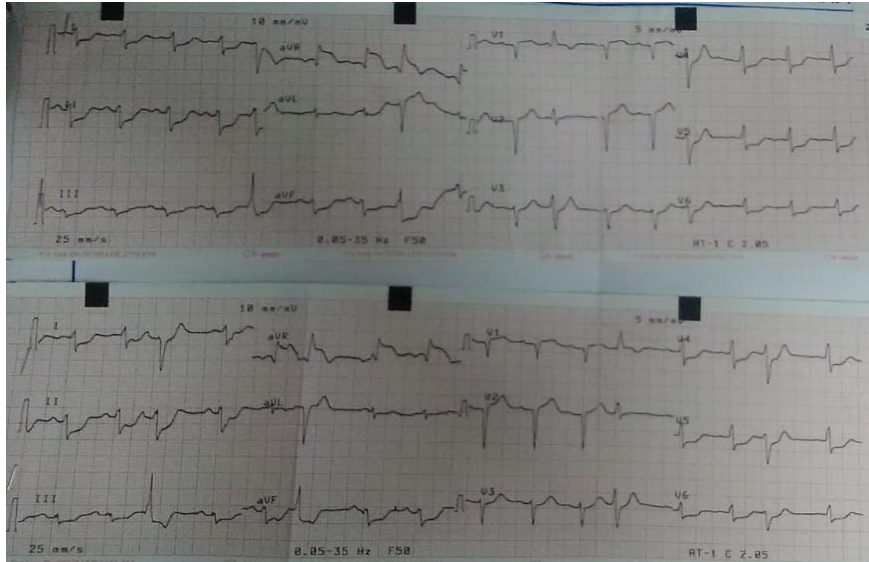


Fig-1: ECG of referral hospital

On admission to the Emergency Room (ER), the patient presented with complaints of constant retrosternal chest pain that did not radiate. The pain has been felt in the last 9 hours before arriving at the ER, the patient was previously said to have had a heart attack one month ago, but at that time refused to do cardiac catheterization. Previous medical history of uncontrolled diabetes mellitus and dyslipidemia. The patient's risk factors for coronary artery disease (CAD) included a previous smoking history and a positive family history of early cardiovascular disease. Physical

examination revealed a systolic ejection murmur with an absent S2 heart sound in the aortic area.

The patient underwent an ECG examination in the ER, and a sinus tachycardia rhythm with STEMI LM equivalent appeared to have spontaneous resolution compared to the previous ECG (figure 2). Given the ECG findings, the patient was taken directly to the cardiac catheterization lab for coronary angiography and primary percutaneous coronary intervention (PPCI).

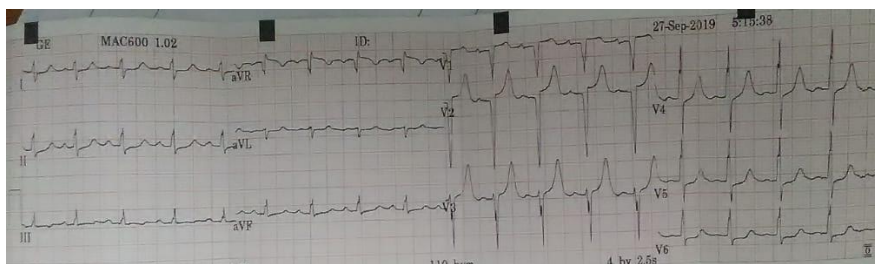


Fig-2: ECG when arriving at the ER

Coronary angiography shows non-significant 40-50% stenosis of the distal right coronary artery (RCA) and diffuse disease with a maximum of 50% stenosis of the mid-left anterior descending (LAD) artery. Meanwhile, the left main coronary artery (LMCA) and left circumflex (LCX) appeared normal

without stenosis (Figure 3). Later laboratory results revealed an increase in troponin I > 50,000 ng/mL (normal: < 0.04 ng/mL). Abnormalities of other laboratory parameters include an increase in leukocytes 18.000/μL, GDA 364 mg/dL, SGOT 68 U/L, and serum creatinine 1.48 mg/dL.

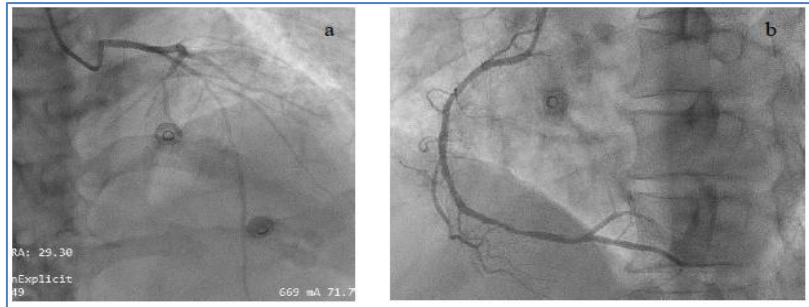


Fig-3: Coronary angiography: (a) left coronary artery (b) right coronary artery

Then bedside echocardiography was performed, obtained a picture of aortic stenosis on color Doppler (Figure 4) with qualitative critical aortic stenosis: Vmax 4.06 m/s, Max PG 65.88 mmHg, Mean PG 42.94 mmHg, AVA (VTI) 0.4 cm², and AVA

Planimetry 0.5 cm². A short axis view of the aortic valve (AV) shows a calcified AV with limited mobility and narrow valve opening (Figure 5) with LVH with no regional wall abnormalities.

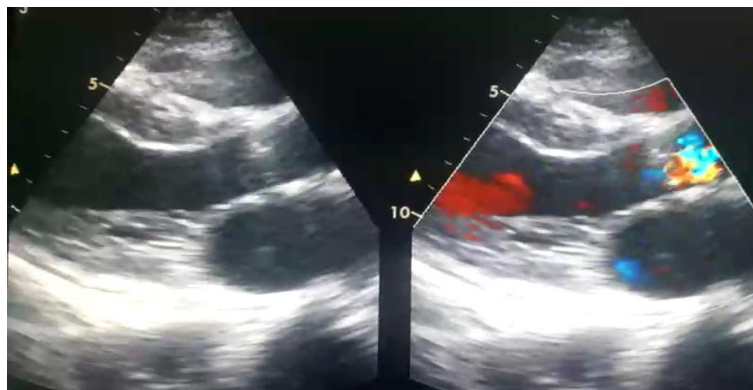


Fig-4: Echocardiography using color doppler on the parasternal long axis (PLAX) view, we get an image of the AS jet

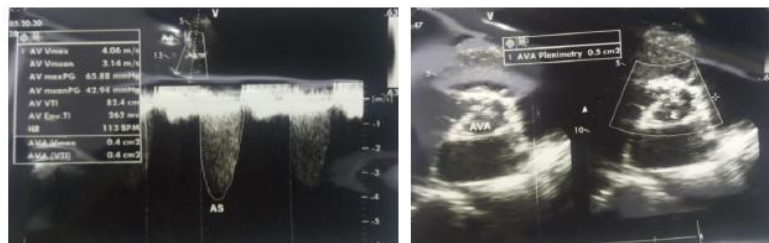


Fig-5: Quantitative measurements show critical AS

Prior to coronary angiography, the patient was given loading with aspirin and clopidogrel. After identification of critical AS by echocardiography, antiplatelet therapy was discontinued and the patient was transferred to the intensive cardiac care unit (ICCU) for further treatment given the ongoing ischemic chest pain, with persistent ST-segment elevation and no evidence of coronary occlusion. This case was discussed with a team of cardiac surgeons and the patient was planned for urgent AV replacement. The patient then underwent uncomplicated aortic valve replacement surgery and no longer had any symptoms after 12 weeks of follow-up.

DISCUSSION

Severe aortic stenosis usually causes compensatory left ventricular hypertrophy. Ventricular

hypertrophy can cause a decrease in coronary vasodilator reserve (CVR), which is the ratio of maximal to basal coronary blood flow. CVR can be used as a functional index of the severity of coronary artery insufficiency even though coronary arteries are angiographically normal[9] Similar reductions in CVR have also been observed in patients with hypertrophic and hypertensive cardiomyopathy[10]. In these patients, diastolic perfusion time (DPT) had a significant effect on CVR: the faster the heart rate, the lower the CVR[11]. The combination of left ventricular hypertrophy, tachycardia, and lower perfusion pressure (which can occur with critical aortic stenosis) will significantly impair subendocardial perfusion resulting in ischemia (Figure 6). Rajappan et al. showed that there is no clear relationship between the degree of hypertrophy and CVR whereas on the other hand the interaction of DPT and valve area appears to be an

important parameter in the development of ischemia in aortic stenosis[12]. Other diagnoses of STEMI with non-obstructive coronary are acute aortopathy,

endocarditis with embolus, myopericarditis, and intracranial hemorrhage.

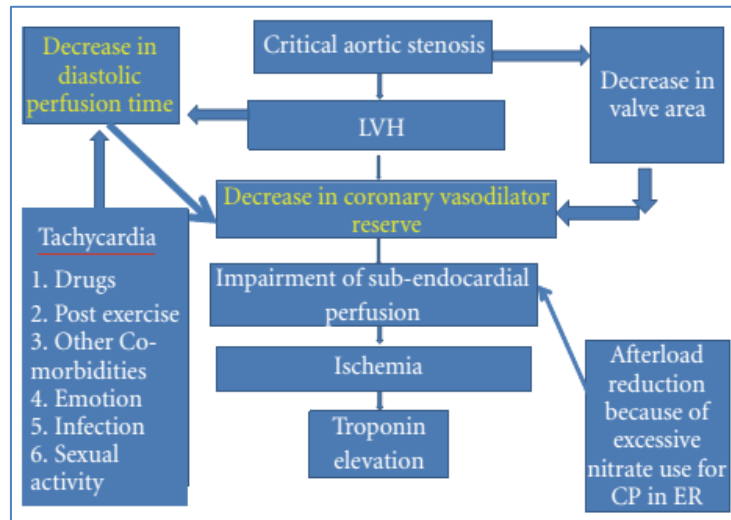


Fig-6: Pathophysiology of troponinemia in patients with critical aortic stenosis[13]

In this case of critical aortic stenosis presenting as an acute coronary syndrome. The importance of a thorough physical examination and the early use of noninvasive tests such as echocardiography, ECG and laboratories are crucial in establishing the diagnosis.

1. Physical Examination

The aortic stenosis ejection murmur begins in systole after S1, which is separated by a short vocal gap. This cleft occurs with a period of isovolumetric contraction of the left ventricle (the period after the mitral valve closes but before the aortic valve opens). The murmur becomes more intense as flow increases through the aortic valve during an increase in left ventricular pressure (crescendo). Then, as the ventricle relaxes, forward flow decreases and the intensity of the murmur decreases (decrescendo) and finally ends before the S2 aortic component. The murmur may be immediately preceded by an ejection click, especially in mild aortic stenosis.

Although the intensity of the murmur does not correlate well with the severity of aortic stenosis, other features do. For example, the more severe the stenosis, the longer it takes to force blood through the valve, and the more delayed the peak of the murmur in systole (Figure 7). As the severity of the stenosis increases, the aortic component S2 progressively decreases as the valve becomes more rigid in place.

Aortic stenosis causes a high-frequency murmur, reflecting a considerable pressure gradient through the valve. It is best heard in the "aortic area" in the second and third right intercostal spaces close to the sternum. The murmur usually radiates to the neck (direction of turbulent blood flow) but is often heard in a wide distribution, including the cardiac apex.

Physical examination often allows accurate detection and estimation of the severity of AS. The hallmark features of advanced AS, include a rough late peak ejection systolic murmur and a weakened (parvus) and delayed ascending motion (tardus) of the carotid artery due to obstructed left ventricular outflow. Other common findings on cardiac examination include the presence of an S4 (due to "stiff" atrial-to-LV contractions) and reduced intensity, or complete absence, of the aortic component of the S2 sound[14].

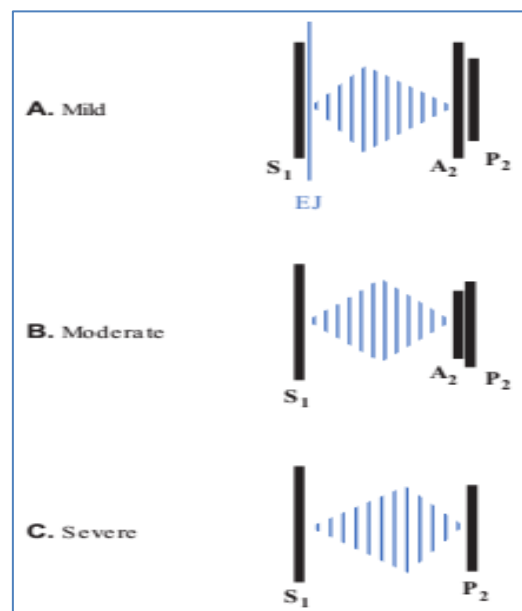


Fig-14: The severity of aortic stenosis affects the shape of the systolic murmur and heart sounds. In severe stenosis (C), the murmur peaks very late in the systole phase, and A2 is usually absent because of the immobility of the valve. S1, first heart sound; S2, second heart sound[14].

In this case, auscultation and other physical examination of the patient gave a clinical picture consistent with that of severe aortic stenosis.

2. ECG

ST-segment elevation on the ECG usually occurs in type 1 acute myocardial infarction. However, there are other conditions that can cause ST-elevation features on the ECG (See table 1)[15].

Table-1: Clinical conditions causing ST segment elevation on ECG[15].

Neurological	Subarachnoid hemorrhage
Coronary	Coronary artery aneurysm, coronary artery occlusion, coronary artery stenosis, spontaneous coronary artery dissection, Prinzmetal angina, cocaine abuse
Cardiac	Pericarditis, myocarditis, perimyocarditis, Brugada syndrome, left ventricular hypertrophy, left bundle branch block, cardioversion, takotsubo cardiomyopathy, cardiac compression
Vascular	Aortic dissection, pulmonary thromboembolism
Pulmonary	Pneumonia, COPD, mediastinal tumor
Abdominal	Cholecystitis, pancreatitis, hiatal hernia, subdiaphragmatic abscess, peritonitis
Electrolytes	Hyperkalemia, hyper/hypophosphatemia
Endocrine	Pheochromocytoma, thyroid storm

In the ECG examination, there was a discrepancy between the patient's ECG images and AS when compared with the ECG found in the three cases. Very high risk NSTEMI (ST elevation aVR, ST depression II, III, aVF, I, V4-6) (figure 1) accompanied by complaints of typical chest pain in the patient, causing the patient to be suspected of having acute coronary syndrome (ACS) as one of the one initial diagnosis when the patient arrives at the ED.

3. Echocardiography

Echocardiography is a more sensitive technique for assessing left ventricular wall thickness and displays abnormal anatomy and decreased excursion of the stenotic valve. Transvalvular pressure gradient and aortic valve area can be calculated easily with Doppler echocardiography[14].

In this case, the echocardiographic results were consistent with critical aortic stenosis. There is a calcified AV image with limited mobility and narrow valve opening, which is indicated by qualitative calculations in the form of AVA planimetry obtained with a size of 0.5 cm² (figure 5). In addition, there was also an LVH picture without regional wall abnormalities, which made the echocardiography in patient not compatible with the ACS patient.

3. Laboratorium (Cardiac troponin I)

Cardiac troponin I (cTnI) is detected in more than half and is elevated in more than one fifth of patients with severe aortic stenosis. Extreme elevations in cardiac troponin are rare in the absence of an acute

coronary syndrome. The mechanism underlying the extreme elevation in cardiac biomarkers in patients with critical aortic stenosis remains unclear but could be associated with decreased coronary vasodilator reserve and diastolic perfusion time. cTnI may be elevated even in the absence of systolic dysfunction, indicating that cTnI may precede LV dysfunction.[13] Serial cTnI monitoring can help clinicians identify the onset of the inevitable clinical decline in severe aortic stenosis[16].

Cardiac troponin I (cTnI) values were very high in this case (>50,000 ng/mL). In establishing the diagnosis of ACS based on cTnI, the possibility of patient experiencing an ACS is included in the high category. However, there are several clinical conditions that increase cardiac troponin associated with cardiomyocyte injury other than acute type 1 myocardial infarction (see table 2).

Tabel-2: Clinical conditions that increase cardiac troponin associated with cardiomyocyte injury other than acute type 1 myocardial infarction [17]

Tachyarrhythmias
Heart failure
Hypertensive emergencies
Critical illness (e.g. shock/sepsis/burns)
Myocarditis^a
Takotsubo syndrome
Valvular heart disease (e.g. aortic stenosis)
Aortic dissection
Pulmonary embolism, pulmonary hypertension
Renal dysfunction and associated cardiac disease
Acute neurological event (e.g. stroke or subarachnoid haemorrhage)
Cardiac contusion or cardiac procedures (CABG, PCI, ablation, pacing, cardioversion, or endomyocardial biopsy)
Hypo- and hyperthyroidism
Infiltrative diseases (e.g. amyloidosis, haemochromatosis, sarcoidosis, scleroderma)
Myocardial drug toxicity or poisoning (e.g. doxorubicin, 5-fluorouracil, herceptin, snake venoms)
Extreme endurance efforts
Rhabdomyolysis

Treatment

1. Perform Coronary Angiography Diagnostics If Coronary Abnormalities Are Suspected, Followed by Reperfusion Measures According to Indications

It is important to perform coronary angiography as soon as possible in patients with severe valvular heart disease who are also suspected of having an acute myocardial infarction. If there is significant coronary artery stenosis or a total coronary artery occlusion suspected to be the cause of acute myocardial infarction, it is necessary to perform reperfusion immediately according to the indications based on the

guidelines for STEMI patients or according to the NSTEMI guidelines adjusted to the degree the risk[1,18] If surgical reperfusion with aortic valve replacement (AVR) cannot be performed within the time window according to STEMI or NSTEMI guidelines, percutaneous reperfusion may be considered to save the myocardium before necrosis occurs.

Although it turned out that at the time of coronary diagnostic angiography (DCA) no significant coronary stenosis was found that could be suspected as the cause of myocardial infarction, the DCA results can be used as preparation for aortic valve replacement (AVR)[19].

2. IABP placement procedure

In a similar case of critical aortic valve stenosis with STEMI features published by Gue *et al.* in 2017, there was rapid resolution of chest pain and resolution of ST-segment elevation on ECG after IABP placement. ECG changes in the form of persistent ST-segment elevation in the absence of severe coronary artery stenosis and good response to IABP strongly suggest that the cause of the patient's presentation is valvular [20]. Placement of IABP in patients may improve outcomes because IABP can increase blood flow to the myocardium via the coronary arteries, especially because the patient has no evidence of significant coronary artery stenosis.

3. Consider Urgent Aortic Valve Intervention in Patients with Severe Aortic Valve Stenosis with Symptoms

Early intervention therapy is strongly recommended in all patients with severe aortic stenosis who have symptoms because of their poor spontaneous prognosis. The only exceptions to the intervention were patients with severe comorbidities who demonstrated a survival of <1 year, and patients with severe comorbidities or their general condition in old age making the intervention unlikely to improve quality of life or survival. As long as the mean gradient remained >40 mmHg, there was virtually no lower ejection fraction limit for intervention, either surgery or TAVI.[19]

4. Medical Therapy in Patients with Symptomatic Aortic Stenosis Should be according to the Heart Failure Guidelines, and also according to the ACS Guidelines if Significant Coronary Artery Occlusion/Stenosis is Suspected

The definitive treatment for symptomatic severe AS is AVR, either by transcatheter or conventional open-heart surgery. So far, there is no medical therapy that has been shown to definitely improve the prognosis of the disease[21]. Randomized trials have consistently shown that statins do not affect the development of aortic stenosis. Patients with symptoms of heart failure who are not eligible for surgery or TAVI, as well as patients currently awaiting

surgical intervention or catheterization, should be treated medically according to heart failure guidelines. Existing hypertension should be treated. Administration of hypertensive drugs in patients with severe AS should be carefully titrated to avoid hypotension and frequent re-evaluation. Maintaining sinus rhythm is also an important concern[19].

Administration of medication in accordance with the guidelines for acute coronary syndromes can be given when significant occlusion or stenosis of the coronary arteries is suspected. Dual antiplatelet therapy (DAPT) and high-intensity statins can be administered directly to the patient. However, the administration of nitrates in patients with severe AS should be very careful because it has the potential to cause hypotension as in other antihypertensives which must be monitored closely[21].

CONCLUSION

This case emphasizes the importance of a thorough physical examination, ECG, echocardiography, and cardiac markers that we perform initially in a patient with aortic valve stenosis presenting with an acute coronary syndrome. Extreme elevations in cardiac troponin are rare in the absence of the syndrome in patients with critical aortic stenosis is still unclear, but may be associated with decreased coronary vasodilator reserve and diastolic perfusion time.

The definitive treatment for symptomatic severe AS is AVR, either by transcatheter or conventional open-heart surgery. Some of the treatments that can be performed on these patients are: immediately perform reperfusion measures if there is suspicion of coronary artery occlusion or stenosis that can cause myocardial infarction; Installation of IABP if there are signs of myocardial damage by paying attention to contraindications for IABP placement; intervene as soon as possible on the patient's aortic valve according to guideline recommendations; Administration of medical therapy according to heart failure guidelines in symptomatic severe AS patients and additional medical therapy according to ACS guidelines if significant coronary artery occlusion or stenosis is suspected in the patient.

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