

CASE REPORT

Transcatheter ventricular septal rupture closure: A challenging case of basal inferoseptal aneurysm and rupture

Transkateter ventriküler septal rüptür kapanması: Zorlu bir bazal inferoseptal anevrizma ve rüptür olgusu

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Summary– Ventricular septal rupture (VSR) is an ominous mechanical complication of acute myocardial infarction (MI) accompanied with a poor prognosis. Transcatheter closure (TCC) of VSR has been proposed as an alternative approach for surgery. This study presents a 79-year-old man with diabetes mellitus, hypertension, dyslipidemia, and chronic stable angina with 3-vessel coronary artery disease, who had refused a coronary artery bypass graft. He complained of orthopnea and dyspnea of New York Heart Association (NYHA) function class III after the recent neglected inferior MI. Transthoracic echocardiography revealed moderate left ventricular (LV) systolic dysfunction, true aneurysm formation at the base of the inferoseptal wall, as well as a large-sized (12 mm) VSR at the posterior aspect of basal inferoseptal segment with significant left to right shunt and a peak systolic gradient of 50 mm Hg at the VSR site. Given the high risk profile for surgery and patient refusal, he was a candidate for TCC of VSR and staged multi-vessel percutaneous coronary intervention (PCI). A 30 mm Figulla atrial septal defect (ASD) occluder device was chosen and successfully deployed at the VSR site with minimal residual shunt. A month later, successful multi-vessel PCI was performed with good procedural and clinical outcomes on the 6-month follow-up.

Özet– Ventriküler septal rüptür (VSR), kötü prognozla birlikte akut miyokard infarktüsünün (MI) kaygı verici bir mekanik komplikasyonudur. VSR'nin transkateter kapatılması (TCC), cerrahi için alternatif bir yaklaşım olarak önerilmiştir. Bu çalışma, koroner arter bypass greftini reddeden, diabetes mellitus, hipertansiyon, dislipidemi ve 3 damar koroner arter hastalığı ile kronik stabil anjinası olan 79 yaşındaki bir erkek hastayı sunmaktadır. Yakın zamanda ihmal edilen inferior MI'dan sonra ortopne ve New York Kalp Derneği (NYHA) fonksiyon sınıfı III dispneden şikayeti vardı. Trans-toraksik ekokardiyografide orta derecede sol ventriküler (LV) sistolik disfonksiyon, inferoseptal duvarın tabanında gerçek anevrizma oluşumu ve ayrıca bazal inferoseptal segmentin posteriorunda önemli ölçüde soldan sağa şanlı büyük boyutlu bir (12 mm) VSR ve VSR bölgesinde 50 mm Hg'lik bir pik sistolik gradyan izlendi. Cerrahi için yüksek risk profili ve hasta reddi göz önüne alındığında, hasta VSR TCC'si ve aşamalı çok damarlı perkütan koroner girişim (PCI) için adaydı. 30 mm Figulla atriyal septal defekt (ASD) oklüder cihaz seçildi ve minimal rezidüel şantla VSR bölgesine başarıyla yerleştirildi. Bir ay sonra, başarılı çok damarlı PCI uygulandı ve 6 aylık takipte iyi prosedürel ve klinik sonuçlar elde edildi.

Ventricular septal rupture (VSR) is a devastating mechanical complication of acute transmural myocardial infarction (MI). The frequency of VSR has been reduced in the recent era of early reperfusion strategy.^[1] Surgical closure of VSR is the definite therapeutic choice, however high rate of in-hospital death (44%) and late mortality (56%) was reported (from 2005 to 2007).^[2] As transcatheter closure (TCC) of congenital ventricular septal defects is known as an accepted treatment in adults, TCC

of VSR is an alternative to surgical treatment with a high success rate despite overall high mortality as surgical therapy.^[3-7] It has been reported that VSR closure at a later phase of MI (after 14 days of the index event) results in promising clinical outcomes with lower morbidity and mortality.^[8] Technical factors that predict better results in previous studies are simple defects, small defects (<15 mm in diameter), and Amplatzer device selection.^[9] Post-inferior MI VSR is more complex for device closure than apical

Received: August 24, 2020 Accepted: December 13, 2020

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VSR owing to a more serpiginous course and larger defects and nearby the atrioventricular valves.^[10]

We present a 79-year-old male with a late presentation of post-inferior MI VSR at the posterior aspect of the basal inferoseptal wall that was occluded successfully with a 30-mm Figulla ASD occluder and underwent multi-vessel PCI.

CASE REPORT

A 79-year old male, a known patient with diabetes mellitus (for 24 years), hypertension, and dyslipidemia presented to our center with a complaint of dyspnea New York Heart Association (NYHA) class III for a week. He had a history of chronic stable angina with 3 vessel coronary artery disease (from 5 years ago) but had refused coronary artery bypass graft (CABG). A month ago, he presented with typical retrosternal chest pain for more than 48 hours to a local hospital, where an electrocardiogram (ECG) showed pathological Q wave and ST segment elevation in inferior leads as well as diffuse ST segment depression in precordial leads. Emergent coronary angiography revealed significant stenotic lesions in the mid part of the left anterior descending (LAD), proximal of first diagonal (D1), and proximal of left circumflex (LCX) arteries along with critical (99%) diameter stenosis in the mid part of the right coronary artery (RCA). As the patient refused to undergo CABG, he was discharged after 7 days of medical treatment, including enoxaparin, dual antiplatelet therapy, beta-blockers, and angiotensin-converting enzyme inhibitors.

At the time of presentation to our center, the patient was conscious with cold sweats and complained of dyspnea NYHA function class III and orthopnea. On physical examination, he was in sinus rhythm with a blood pressure of 100/70, heart rate of 88 bpm, and respiratory rate of 22/min. Bilateral basilar rales in the lung fields and a grade 3 harsh holosystolic murmur along the left parasternal border radiating to the apex were also noted.

The electrocardiogram revealed normal sinus rhythm, low-voltage limb leads, normal QRS axis, with pathologic Q wave in the inferior leads along with diffuse ST segment depression in the precordial leads. Bedside, transthoracic echocardiography (TTE) showed moderate left ventricular (LV) systolic dysfunction with LV ejection fraction (LVEF)

of 40%, moderate right ventricular (RV) systolic dysfunction, moderate functional mitral regurgitation (MR), akinesia in inferior, inferoseptal, and apicoseptal walls with significant thinning and true aneurysm formation at the base of the inferoseptal wall. A large-sized (12 mm) VSR in the posterior aspect of the basal inferoseptal segment (25 mm from the tricuspid valve [TV]) with significant left to

right shunt was noted. Peak systolic gradient at the level of VSR was estimated as 50 mm Hg, compatible with moderate pulmonary hypertension. Laboratory data revealed normal electrolytes, except for serum potassium of 3.5 mEq/L, estimated glomerular filtration rate (eGFR) of 50.9 mL/min (serum creatinine 1.2 mg/dL), hemoglobin of 13.1 mg/dL, and normal liver enzymes and function tests.

Because of the significant 3-vessel CAD, VSR, and the patient's refusal for CABG despite describing the risks and benefits, a decision was made to perform TCC of VSR and staged multi-vessel PCI by the local expert heart team.

Transcatheter closure of VSR was performed under general anesthesia under fluoroscopic guidance and transesophageal echocardiography (TEE) (Vivid S6, GE, USA). Right femoral arterial and right internal jugular venous (RIJV) accesses were obtained. Using a hydrophilic soft wire via a right femoral artery approach, the ventricular septal defect was crossed from left to right. The wire was placed into the pulmonary artery and was snared from the venous access.

Thereafter, a device delivery sheath crossed the septal defect from the RIJV access, through which a Figulla Flex II ASD occluder (30 mm) was over-

Abbreviations:

VSR	Ventricular septal rupture
MI	Myocardial infarction
TCC	Transcatheter closure
NYHA	New York Heart Association
PCI	Percutaneous coronary intervention
ASD	Atrial septal defect
LV	Left ventricular
CABG	Coronary artery bypass graft
ECG	Electrocardiogram
LAD	Left anterior descending
D1	First diagonal
LCX	Left circumflex
RCA	Right coronary artery
LVEF	LV ejection fraction
RV	Right ventricular
TTE	Transthoracic echocardiography
TEE	Transesophageal echocardiography
RIJV	Right internal jugular venous
MV	Mitral valve
MR	Mitral regurgitation
TV	Tricuspid valve
eGFR	Estimated glomerular filtration rate
CAD	Coronary artery disease

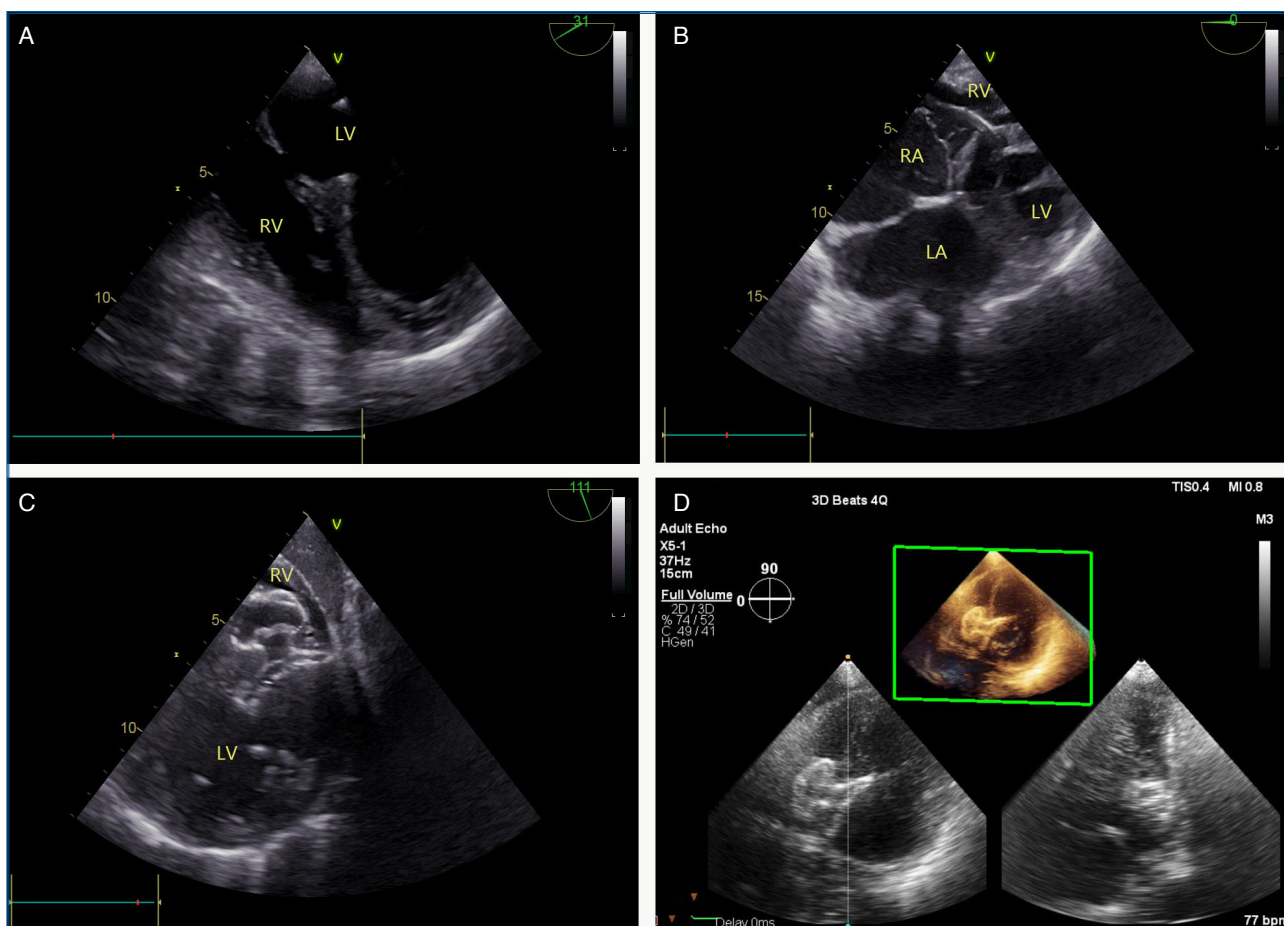


Figure 1. Intraoperative transesophageal echocardiography (TEE) and post-procedural 3 dimensional (3D) transthoracic echocardiography (TTE). **(A)** Transesophageal 4-chamber view (0°) focused on ventricles shows true aneurysm at the base of inferior septum associated with VSR. **(B)** Delivery sheath crossing the VSR in 0° trans-gastric view. **(C)** Device deployment in 110° trans-gastric view. **(D)** 3D TTE performed 1 week after the procedure reveals the device in proper position.

passed. The large defect size and thin septum at the VSR site enabled us to choose the ASD device over VSD 1 for closure of the defect. Under TEE guidance, the LV disc of the device was extruded from the sheath and opened without interfering with the mitral valve (MV) chorda apparatus (Fig. 1, 2). Withdrawing the device toward the interventricular septum, the RV disc was also deployed in proper position. TEE confirmed proper alignment of the device with the interventricular septum without interference with the MV and TV apparatus and function as well as significant shunt reduction with 5 mm residual defect, and the device was released from delivery sheath (Video 1, 2, 3*). Blood pressure (BP) increased from 70/50 just before procedure to 100/70 just after the VSR device closure. Follow-up TTE after 1 week showed improvement in the LV systolic function (LVEF 45%), minimal left to right shunt with a peak gra-

dient of 60 mm Hg (Figure 1, Video 4*). During the 1-month follow-up visit, the patient had stable vital signs and dyspnea NYHA function class III without orthopnea. Successful staged multi-vessel PCI was performed on LAD, LCX, and RCA with good procedural outcome without complications, except for a transient increase in serum creatinine (up to 1.7 mg/dL) that resolved with hydration and supportive care. The suitable device position was confirmed during the study (Video 5*). On the 6-month follow-up visit, the patient had no chest pain with mild dyspnea on exertion (NYHA functional class of I–II).

DISCUSSION

Post MI VSR is a rare and ominous mechanical complication of acute MI with modern early reperfusion strategies.^[1,2,11] The clinical outcome of surgical re-



Figure 2. Intra-procedural fluoroscopy. **(A)** Figulla Flex II atrial septal defect occluder in proper position with mild entrapment of right ventricle (RV) disk in tricuspid valve (TV) apparatus. **(B)** Final proper device position after release without any interference with MV and TV apparatus.

pair as the therapeutic approach of choice has been evaluated in multiple reviews, and they report a high mortality rate of 42.9% overall and 80.5% in rescue situations.^[5,12] Given the high surgical risk and mortality rate in an acute setting, TCC of VSR as an alternative therapeutic approach has been accepted with promising results in select patients at later stages post MI.^[4,8,13] In a systematic review of 13 case series of TCC for post MI VSR including 278 patients, 48% of the patients were in cardiogenic shock, and 42% of procedures were performed in an acute setting (<14 days of the index MI event). They reported a high technical success rate of >75%, successful device implantation of 89%, and overall 30-day mortality of 32%.^[3] Zhu et al.^[14] have reported an excellent success rate of 92.3% and in-hospital mortality of 14.3% in a case series of 35 patients with TCC of VSR, where 37% of the procedures were performed in an urgent setting. Clinical criteria associated with worse outcomes in the long-term follow up of 53 patients after TCC of VSR in a multicenter study were intervention in an acute setting rather than chronic phase, female sex, older age, larger defects, high NYHA class, and shock state at presentation.^[4] In a single center retrospective study, the major clinical risk factors for mortality were cardiogenic shock at

presentation, multiorgan dysfunction, and high ratio of pulmonary to systemic flow.^[6] Our patient was a 79-year-old male in late stage (at least 30 days) after acute inferior MI, stable vital signs, good renal function tests without multi-organ failure who refused any surgical intervention, all of which made him a suitable case for the percutaneous procedure.

In terms of the technical aspects, a VSR size <15 mm is considered optimal for device closure, and at least 50% oversizing in device selection is recommended.^[5,9] Basal inferoseptal VSR is more challenging for device closure than apical VSR owing to the complex course, larger defects, inadequate septal rims, and possible interference with adjacent structures, especially TV apparatus that restrict device size selection.^[5,10] Our patient had a straight basal infero-posterior septal rupture at the base of a true aneurysm with optimal size (12 mm) for TCC and adequate distance from TV (25 mm). Although there was a small (5 mm) residual defect, the acceptable clinical response together with improvement in LV and RV functions as well as decrease in pulmonary artery pressure were observed. This then led to a successful multi-vessel PCI in an elective setting 1 month later.

TCC of VSR accompanied by multi-vessel PCI is an acceptable alternative to surgical treatment with a high success rate in experienced hands, especially in defects >15 mm, late phase after acute MI, and a relatively stable patient.

*Supplementary video files associated with this article can be found in the online version of the journal.

Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Peer-review: Externally peer-reviewed.

Authorship contributions: Concept - M.P., A.F., R.K., A.S.; Design - M.P., A.S.; Supervision - M.P., A.F.; Materials - M.P., A.F., R.K., A.S.; Literature search - A.S.; Writing - A.S.; Critical revision - M.P., A.F., R.K.

Conflict-of-interest: None.

REFERENCES

- Honda S, Asaumi Y, Yamane T, Nagai T, Miyagi T, Noguchi T, et al. Trends in the clinical and pathological characteristics of cardiac rupture in patients with acute myocardial infarction over 35 years. *J Am Heart Assoc* 2014;3:000984. [\[Crossref\]](#)
- Moreyra AE, Huang MS, Wilson AC, Deng Y, Cosgrove NM, Kostis JB. Trends in incidence and mortality rates of ventricular septal rupture during acute myocardial infarction. *Am J Cardiol* 2010;106:1095-100. [\[Crossref\]](#)
- Schlotter F, de Waha S, Eitel I, Desch S, Fuernau G, Thiele H. Interventional post-myocardial infarction ventricular septal defect closure: a systematic review of current evidence. *EuroIntervention* 2016;12:94-102. [\[Crossref\]](#)
- Calvert PA, Cockburn J, Wynne D, Ludman P, Rana BS, Northridge D, et al. Percutaneous closure of postinfarction ventricular septal defect: in-hospital outcomes and long-term follow-up of UK experience. *Circulation* 2014;129:2395-402. [\[Crossref\]](#)
- Jones BM, Kapadia SR, Smedira NG, Robich M, Tuzcu EM, Menon V, et al. Ventricular septal rupture complicating acute myocardial infarction: a contemporary review. *Eur Heart J* 2014;35:2060-8. [\[Crossref\]](#)
- Assenza GE, McElhinney DB, Valente AM, Pearson DD, Volpe M, Martucci G, et al. Transcatheter closure of post-myocardial infarction ventricular septal rupture. *Circ Cardiovasc Interv* 2013;6:59-67. [\[Crossref\]](#)
- Pekel N, Ercan E, Özpelit ME, Özyurtlu F, Yılmaz A, Topaloğlu C, et al. Directly ventricular septal defect closure without using arteriovenous wire loop: our adult case series using transarterial retrograde approach. *Anatol J Cardiol* 2017;17:461-8. [\[Crossref\]](#)
- Faccini A, Butera G. Techniques, timing, and prognosis of transcatheter post myocardial infarction ventricular septal defect repair. *Curr Cardiol Rep* 2019;21:59. [\[Crossref\]](#)
- Attia R, Blauth C. Which patients might be suitable for a septal occluder device closure of postinfarction ventricular septal rupture rather than immediate surgery? *Interact Cardiovasc Thorac Surg* 2010;11:626-9. [\[Crossref\]](#)
- Hamilton MCK, Rodrigues JCL, Martin RP, Manghat NE, Turner MS. The in vivo morphology of post-infarct ventricular septal defect and the implications for closure. *JACC Cardiovasc Interv* 2017;10:1233-43. [\[Crossref\]](#)
- Birnbaum Y, Fishbein MC, Blanche C, Siegel RJ. Ventricular septal rupture after acute myocardial infarction. *N Engl J Med* 2002;347:1426-32. [\[Crossref\]](#)
- Arnaoutakis GJ, Zhao Y, George TJ, Sciortino CM, McCarthy PM, Conte JV. Surgical repair of ventricular septal defect after myocardial infarction: outcomes from the Society of Thoracic Surgeons National Database. *Ann Thorac Surg* 2012;94:436-43. [\[Crossref\]](#)
- Demkow M, Ruzyllo W, Kepka C, Chmielak Z, Konka M, Dzielinska Z, et al. Primary transcatheter closure of postinfarction ventricular septal defects with the Amplatzer septal occluder-immediate results and up-to 5 years follow-up. *EuroIntervention* 2005;1:43-7.
- Zhu XY, Qin YW, Han YL, Zhang DZ, Wang P, Liu YF, et al. Long-term efficacy of transcatheter closure of ventricular septal defect in combination with percutaneous coronary intervention in patients with ventricular septal defect complicating acute myocardial infarction: a multicentre study. *EuroIntervention* 2013;8:1270-6. [\[Crossref\]](#)

Keywords: Myocardial infarction; cardiac aneurysms; septal occluder device; ventricular septal rupture

Anahtar Kelimeler: Myokard enfarktüsü; kardiyak anevrizmalar; septal oklüder cihazı; ventriküler septal rüptür