

A case report of pericardial constriction with coexisting severe left main coronary artery disease

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Background

Constrictive pericarditis (CP) is a rare condition in which the pericardium becomes progressively fibrotic and non-compliant leading to impaired ventricular filling and overt heart failure. While CP shares many clinical and haemodynamic similarities with restrictive cardiomyopathy, differentiation of these diseases is crucial as CP is potentially curative through pericardiectomy. Here, we present a case of proven pericardial constriction with atypical haemodynamics in a patient presenting with heart failure and severe left main coronary artery disease (CAD).

Case summary

A 69-year-old female with a history of hypertension and paroxysmal atrial fibrillation presented with persistent heart failure refractory to diuretics. Ischaemic and infiltrative work-up were found to be negative with magnetic resonance imaging demonstrating trace pericardial fluid and thickening of the pericardium. Echocardiogram and right-heart catheterization demonstrated atypical haemodynamics suggestive of but not conclusive for CP, with coronary angiogram demonstrating severe left main CAD. Ultimately, the patient underwent coronary artery bypass grafting along with pericardiectomy and pericardial biopsy demonstrating constrictive physiology.

Discussion

We suspect the inconclusive nature of the echocardiogram and cardiac catheterization was likely secondary to severe CAD impairing left ventricular relaxation and dampening ventricular interdependence. As such, clinicians should consider the possibility of coexistent severe CAD in patients with a clinical suspicion of CP, but inconclusive haemodynamics.

Keywords

Constrictive pericarditis • Restrictive cardiomyopathy • Coronary artery disease • Haemodynamics • Case report

ESC Curriculum

2.1 Imaging modalities • 2.2 Echocardiography • 6.6 Pericardial disease • 3.1 Coronary artery disease • 3.4 Coronary angiography

Learning points

- Review differentiating factors between constrictive pericarditis (CP) and restrictive cardiomyopathy.
- Recognize the characteristic echocardiographic and angiographic haemodynamics of CP, and the possibility of atypical haemodynamics in patients with severe coronary artery disease.

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Introduction

Constrictive pericarditis (CP) is a rare condition with an estimated prevalence of 9–10 cases per million in the USA, where the pericardium becomes progressively fibrotic and non-compliant, culminating in heart failure due to impaired ventricular filling.¹ While it may develop from any inflammatory process of the pericardium, the leading causes of this condition in developed nations are viral pericarditis, followed by cardiac surgery and mediastinal radiation.² Constrictive pericarditis shares many similarities to restrictive cardiomyopathy (RCM) in both clinical and haemodynamic presentation. Although differentiation of these diseases is complex and often challenging, it is crucial given their different managements. Constrictive pericarditis has the potential of cure with pericardiectomy, whereas RCM is typically incurable.³ We present a case of proven pericardial constriction with mixed constrictive and restrictive physiology in a patient presenting with heart failure and severe left main coronary artery disease (CAD).

Timeline

August 2017	First presentation of heart failure
April 2018	MRI demonstrating pericardial effusion and pericardial thickening
July 2019	Right pleural decortication performed for effusion refractory to diuretics
September 2019	Subsequent right pleural decortication
July 2020	Right and left heart catheterization
July 2020	CABG and pericardiectomy

Case presentation

A 69-year-old female with a history of stable psoriatic arthritis, paroxysmal atrial fibrillation, hypertension, dyslipidaemia, Type 2 diabetes, and chronic renal impairment was initially evaluated for heart failure after presenting with worsening dyspnoea, orthopnea, pedal oedema, and increasing abdominal girth. Blood pressure, renal and hepatic function remained stable, and electrocardiogram was unremarkable; however, brain natriuretic peptide was 305 pg/mL (reference <100 pg/mL), and chest radiography demonstrated increased interstitial markings with bilateral pleural effusions. Echocardiography revealed an ejection fraction of 55–60% in the absence of diastolic dysfunction or valvular disease (Table 1). Dipyridamole myocardial perfusion imaging was normal. Given clinical picture of congestive heart failure, she was initiated on furosemide 40 mg daily and underwent further evaluation for haemochromatosis, light-chain amyloidosis, and sarcoidosis. Ferritin, iron studies, and serum and urine protein electrophoresis were unremarkable. Magnetic resonance imaging (MRI) demonstrated trace pericardial fluid with thickening and enhancement of the pericardium of uncertain aetiology and chronicity. There was subtle septal bounce in the mid-to-distal left ventricle (LV) raising the possibility of early constrictive physiology (Supplementary material

online, Video S1). However, considering the subtle findings, this diagnosis was not immediately pursued.

Two years after the initial presentation, she continued to have right-sided pleural effusion refractory to diuretics and decortication. She was referred to cardiac function clinic for further assessment. Infiltrative cardiomyopathy was reconsidered. She underwent evaluation for transthyretin amyloidosis with a ^{99m}Tc-Technetium-Pyrophosphate scan with no abnormal uptake. Throughout, furosemide was up-titrated to 80 mg daily and empagliflozin 12.5 mg was initiated with minimal improvement. Clinical suspicion of CP was renewed, and she was referred for cardiac catheterization.

Right-heart catheterization was carried out from the right femoral vein. Pulmonary artery pressures were 51/25 mmHg with a mean of 35 mmHg. Pulmonary artery wedge pressure was 25 mmHg. Cardiac output by thermodilution was 3.4 L/min and pulmonary vascular resistance was 2.9 wood units. Mean right atrial pressure was 22 mmHg with no inspiratory variations, and prominent x and y descents. There was equalization of the right ventricular end-diastolic pressure and left ventricular end-diastolic pressure within 5 mmHg. Simultaneous pressure measurements of the right ventricle (RV) and LV revealed rapid early diastolic filling (Figure 1). However, there was concordant change in the RV and LV pressures with respiration. Thus, catheterization was supportive but not diagnostic of CP. Coronary angiography showed a highly calcified 80% ostial stenosis of the left main stem, and severe stenosis in the mid-right coronary artery. Post-procedure, she was admitted for intravenous diuresis and further investigations.

Repeat echocardiography demonstrated indeterminate LV diastolic function and filling pressure with subtle respirophasic interventricular septal shift, suggesting enhanced interventricular interdependence (Table 2) (Supplementary material online, Video S2). Inferior vena cava was dilated at >21 mm with <50% respiratory variation (Supplementary material online, Video S3). Additionally, superior vena cava systolic flow respiratory variation was blunted at <20 cm/s. However, the mitral and tricuspid E velocity variation and hepatic vein reversal/forward flow ratio were below the threshold typically associated with pericardial constriction. There was no annulus reversus and septal early diastolic mitral annular velocity was <8 cm/s. Overall, echocardiography findings were suggestive but not conclusive of CP.

Table 1 Transthoracic echocardiography: initial echocardiography data

LVEF (%)	55–60
Mitral E/A ratio	1.8
Septal E/e' ratio	7.1
Lateral E/e' ratio	9.2
Septal e' velocity (cm/s)	12.0
Lateral e' velocity (cm/s)	9.2
TR V _{max} (m/s)	2.18
LAVi (mL/m ²)	33.36

LVEF, left ventricular ejection fraction; mitral E/A ratio, ratio between early and late diastolic trans-mitral flow velocities; E/e' ratio, ratio between peak mitral inflow wave velocity and peak mitral annular early diastolic velocity; e', peak mitral annular early diastolic velocity; TR V_{max}, tricuspid regurgitation peak velocity; LAVi, indexed left atrial volume.

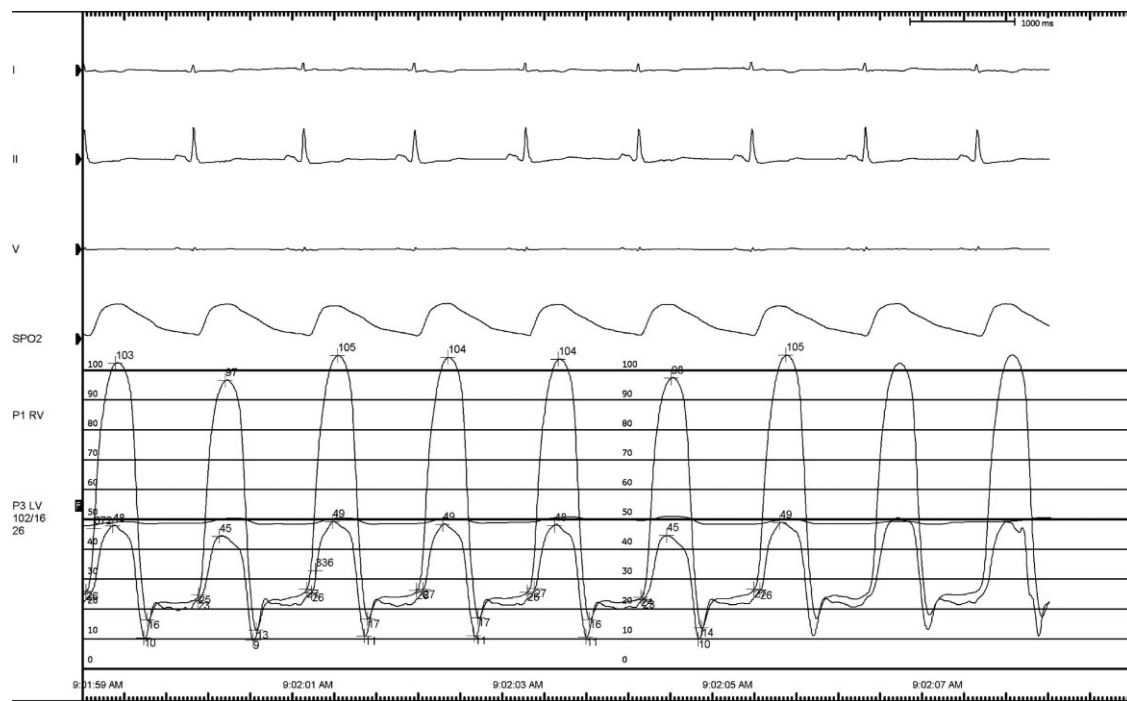


Figure 1 Right-heart catheterization: simultaneous pressure measurements of the right ventricle and left ventricle showing rapid early diastolic filling with 'dip-and-plateau pattern'.

Two weeks post-admission and medical optimization of her heart failure, she underwent successful coronary artery bypass grafting (CABG) and complete pericardectomy. The pericardium was excised from phrenic-to-phrenic nerve anteriorly, along the diaphragmatic surface and posteriorly (Supplementary material online, Video S4). Intraoperatively, the pericardium was noted to be thickened and densely adherent to the myocardium. Intra-procedure pericardial biopsies showed dense sclerosing pericarditis with modest chronic inflammation.

Fourteen months after pericardectomy, there was no recurrence of pleural effusion. She reported symptomatic improvement without further orthopnea and minimal exertional dyspnoea on furosemide 80 mg daily.

Discussion

Echocardiography is often the initial imaging test of choice for signs and symptoms of heart failure seen in constrictive and restrictive physiology. Assessment of ventricular septal motion on echocardiography can provide insight into ventricular interdependence, assessed through respirophasic interventricular septal shifting, present in almost all patients with CP.⁴ Systemic venous congestion is present in both CP and RCM. Furthermore, Doppler echocardiography reveals early rapid ventricular filling with abrupt cessation in both conditions.³ A differentiating feature is the presence of $\geq 25\%$ increase in mitral inflow velocity with expiration, present only in CP.⁵ Tricuspid inflow velocity demonstrates the opposite findings with increase in inflow velocity with inspiration.⁵ Hepatic vein Doppler demonstrates decreased expiratory diastolic hepatic vein forward velocities with large expiratory diastolic reversals in

Table 2 Transthoracic echocardiography: repeat echocardiography data

LVEF (%)	55
Mitral E/A ratio	2.6
Average E/e' ratio	7.5
Septal e' velocity (cm/s)	7.8
Lateral e' velocity (cm/s)	8.8
TR V_{max} (m/s)	2.0
LAVi (mL/m ²)	35

LVEF, left ventricular ejection fraction; mitral E/A ratio, ratio between early and late diastolic trans-mitral flow velocities; E/e' ratio, ratio between peak mitral inflow wave velocity and peak mitral annular early diastolic velocity; e', peak mitral annular early diastolic velocity; TR V_{max} , tricuspid regurgitation peak velocity; LAVi, indexed left atrial volume.

CP.⁴ Another useful parameter to distinguish CP from RCM is mitral annular tissue Doppler assessment. The early diastolic mitral annular velocity of ≥ 8 cm/s has a 95% sensitivity and 96% specificity for the diagnosis of CP.⁶ Computed tomography (CT) and MRI are additional modalities that can detect pericardial thickening, supportive for CP.⁶

When non-invasive testing is inconclusive, cardiac catheterization is useful for the diagnosis of CP and differentiation from RCM. In both diseases, catheterization demonstrates early rapid diastolic filling of the ventricles followed by an abrupt plateau and equalization of end-diastolic pressures known as 'dip-and-plateau pattern'.⁷ Differentiating criteria that favour CP over RCM include equalization of diastolic filling pressures to a difference of ≤ 5 mmHg, a pulmonary

artery systolic pressure <55 mmHg, and a ratio of RV end-diastolic pressure to systolic pressure >1:3.⁸ Similar to echocardiography, ventricular interdependence assessed through respiratory variation in pressures is an important finding in differentiating CP and RCM. In CP, enhancement of ventricular interdependence leads to discordant changes in RV and LV pressures during respiration, while concordant changes are seen in RCM.^{7,8}

While the literature is abundant on the development of CP after CABG in individuals with severe CAD, there is a paucity of data on patients with concomitant CP and severe CAD. Yamada et al.⁹ assessed clinical features of patients with mixed constrictive and restrictive haemodynamics where they determined radiation therapy to be the most frequent cause of mixed physiology followed by CABG. Radiation therapy is also known to cause severe CAD, potentially implicating CAD as a cause of mixed constrictive and restrictive physiology.¹⁰ One well-recognized cause of impaired left ventricular relaxation is severe ischaemia. It is plausible that the features of restrictive filling noted on echocardiography and catheterization could be a consequence of global myocardial ischaemia. The consequent stiffening of the LV could have lessened the prominent ventricular interdependence usually seen with CP.

Conclusion

We document a case of severe left main CAD in association with unequivocal constrictive physiology on biopsy. We suspect the inconclusive nature of the echocardiogram and cardiac catheterization was likely secondary to severe CAD impairing left ventricular relaxation and dampening ventricular interdependence. Clinicians should consider the possibility of coexistent severe CAD in patients with a clinical suspicion of CP but inconclusive haemodynamics, particularly in individuals with atherosclerotic risk factors.

Lead author biography



Dr Sam Ostad Karampour completed his Internal Medicine residency at the University of British Columbia. He is an incoming Cardiology fellow at the University of Alberta in Edmonton, Canada.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

Slide sets: A fully edited slide set detailing these cases and suitable for local presentation is available online as [Supplementary data](#).

Consent: The authors confirm that written consent for submission of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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References

- Mori M, Mullan CW, Bin Mahmood SU, Yousef S, Pelletier KJ, Mangi AA, Geirsson A. US National Trends in the management and outcomes of constrictive pericarditis: 2005–2014. *Can J Cardiol* 2019;**35**:1394–1399. doi:10.1016/j.cjca.2019.05.015
- Bertog SC, Thambidorai SK, Parakh K, Schoenhagen P, Ozduran V, Houghtaling PL, Lytle BW, Blackstone EH, Lauer MS, Klein AL. Constrictive pericarditis: etiology and cause-specific survival after pericardiectomy. *J Am Coll Cardiol* 2004;**43**:1445–1452. doi:10.1016/j.jacc.2003.11.048
- Geske JB, Anavekar NS, Nishimura RA, Oh JK, Gersh BJ. Differentiation of constriction and restriction: complex cardiovascular hemodynamics. *J Am Coll Cardiol* 2016;**68**:2329–2347. doi:10.1016/j.jacc.2016.08.050
- Welch TD, Ling LH, Espinosa RE, Anavekar NS, Wiste HJ, Lahr BD, Schaff HV, Oh JK. Echocardiographic diagnosis of constrictive pericarditis: Mayo Clinic criteria. *Circ Cardiovasc Imaging* 2014;**7**:526–534. doi:10.1161/CIRCIMAGING.113.001613
- Thavendiranathan P, Verhaert D, Walls MC, Bender JA, Rajagopalan S, Chung Y-C, Simonetti OP, Raman SV. Simultaneous right and left heart real-time, free-breathing CMR flow quantification identifies constrictive physiology. *JACC Cardiovasc Imaging* 2012;**5**:15–24. doi:10.1016/j.jcmg.2011.07.010
- Ha J-V, Ommen SR, Tajik AJ, Barnes ME, Ammass NM, Gertz MA, Seward JB, Oh JK. Differentiation of constrictive pericarditis from restrictive cardiomyopathy using mitral annular velocity by tissue Doppler echocardiography. *Am J Cardiol* 2004;**94**:316–319. doi:10.1016/j.amjcard.2004.04.026
- Sorajja P. Invasive hemodynamics of constrictive pericarditis, restrictive cardiomyopathy, and cardiac tamponade. *Cardiol Clin* 2011;**29**:191–199. doi:10.1016/j.ccl.2011.01.003
- Talreja DR, Nishimura RA, Oh JK, Holmes DR. Constrictive pericarditis in the modern era: novel criteria for diagnosis in the cardiac catheterization laboratory. *J Am Coll Cardiol* 2008;**51**:315–319. doi:10.1016/j.jacc.2007.09.039
- Yamada H, Tabata T, Jaffer S, Drinko J, Jasper S, Lauer M, Thomas J, Klein A, et al. Clinical features of mixed physiology of constriction and restriction: echocardiographic characteristics and clinical outcome. *Eur J Echocardiogr* 2007;**8**:185–194. doi:10.1016/j.euje.2006.03.003
- Jaworski C, Mariani JA, Wheeler G, Kaye DM. Cardiac complications of thoracic irradiation. *J Am Coll Cardiol* 2013;**61**:2319–2328. doi:10.1016/j.jacc.2013.01.090