

Mitral-annular Velocity Dynamics in CCP: Illustrating the Reversus-paradoxus Signs

Souvik Dey¹, Ramesh Kashav², Rohan Magoon³, Iti Shri⁴

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ABSTRACT

Chronic constrictive pericarditis (CCP) is inherently associated with diastolic dysfunction. However, the relationship between: (1) Lateral to medial mitral annular velocity and (2) The ratio between early mitral inflow velocity and mitral annular early diastolic velocity (E/e') to left atrial (LA) pressure is significantly altered in CCP. The present article highlights the same.

Keywords: Annulus paradoxus, Annulus reversus, Chronic constrictive pericarditis, Perioperative echocardiography.

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CASE DESCRIPTION

A 26-year-old female had a history of pulmonary tuberculosis 3 years back and was treated with antitubercular drugs for 7 months. On completion of anti-tuberculosis therapy, she developed ascites, pedal edema, exercise intolerance, and orthopnea for 8–9 months. Extensive pericardial calcification was revealed on lateral chest X-ray. Two-dimensional transthoracic echocardiography (TTE) demonstrated pericardial effusion with thickened and calcified pericardium and dilated inferior vena cava with loss of respiratory variability. Subsequently, the patient was diagnosed with CCP and posted for pericardiectomy following medical optimization.

After attaching all the standard monitors, the patient was induced and intubated with the standard institutional protocol. Following induction, transesophageal echocardiographic [(TEE), X7-2t matrix array probe, Philips Epiq 7, Bothell, Washington] examination confirmed the findings of TTE (pericardial effusion with thickened, calcified pericardium). Under the diastolic function evaluation protocol, an end-expiratory peak transmitral flow velocity (mitral E) of 67 cm/second (Fig. 1A) was recorded with an increased respiratory variation. Tissue Doppler imaging (TDI) of lateral and medial mitral annuli documented e' velocities of 9.7 cm/second and 11.5 cm/second, respectively. Subsequently, the calculation of E/e' ratio (lateral E/e' = 6.9; medial E/e' = 5.8; average E/e' = 6.4) revealed normal left ventricular (LV) filling pressure (Figs 1B and C). However, pulmonary venous Doppler interrogation depicted a systolic/diastolic (S/D) ratio of 0.6 (Fig. 1D), indicating increased LA pressure. Due to ambiguity in the estimation of LV filling pressure, LA pressure was directly measured by needle transduction and found to be elevated (19 mm Hg). The surgery went uneventful, and the patient was extubated in the postoperative intensive care unit after 4 hours of elective mechanical ventilation.

Assessment of LV diastolic dysfunction is the holy grail of the attending anesthesiologist. Constrictive pericarditis is inexorably associated with diastolic dysfunction of LV. With an improved understanding of LV diastology, intraoperative TEE-based

^{1–3}Department of Cardiac Anesthesia, Atal Bihari Vajpayee Institute of Medical Sciences & Dr. Ram Manohar Lohia Hospital, New Delhi, India

⁴Department of Anaesthesia, Atal Bihari Vajpayee Institute of Medical Sciences & Dr. Ram Manohar Lohia Hospital, New Delhi, India

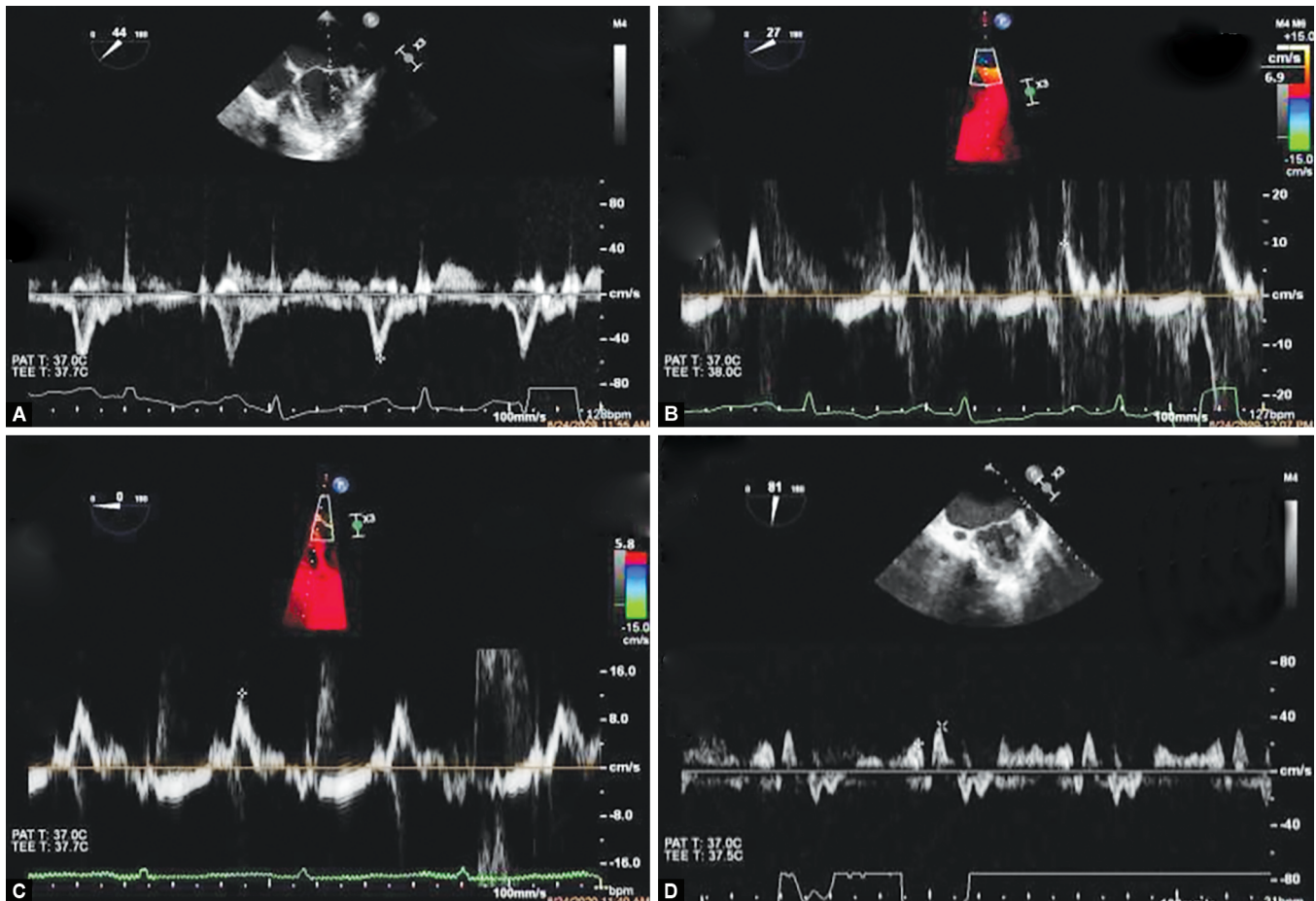
Corresponding Author: Ramesh Kashav, Department of Cardiac Anesthesia, Atal Bihari Vajpayee Institute of Medical Sciences & Dr. Ram Manohar Lohia Hospital, New Delhi, India, Phone: +91 9968654601, e-mail: drkashav@yahoo.co.in

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assessment of mitral valve annular (septal and lateral) velocity (e') serves as an estimation of LV relaxation. A ratio of E/e' gives an account of LV end diastolic pressure (LVEDP):¹ an E/e' ratio of >15 (measured at septal annulus), >12 (measured at lateral annulus), and >13 (if the average of the e' value is taken) indicates an elevated LV filling pressure.² A quantitative evaluation of LVEDP can be obtained by Nagueh formula.² as follows: LVEDP = 1.5 + 1.5 (E/e'). In the present case, TDI of mitral annulus demonstrated two peculiar findings: firstly, despite an elevated e' and low E/e' (average E/e' = 6.4; LVEDP = 11 mm Hg by Nagueh formula), the LA pressure was elevated as captured during LA needle transduction (19 mm Hg); and secondly, e' velocity at septal annulus was greater than the lateral annulus e' velocity (annulus reversus) due to the restricted motion of the lateral annulus by the constrictive pericarditis pathology.³ This falsely low E/e' value despite an elevated LA pressure is classically described as "annulus paradoxus" sign in constrictive pericarditis.⁴ Although pulmonary venous Doppler examination estimated an S/D ratio of 0.6 demonstrated an elevated LV filling pressure, a quantitative estimation was impossible (by TEE-based assessment) in this particular case due to the paradoxically low E/e' ratio.



Figs 1A to D: Intraoperative TEE examination depicting annulus reversus and annulus paradoxus in CCP. (A) Trans-mitral peak inflow velocity (E) measured with pulse wave Doppler; (B) TDI of lateral mitral annulus and estimation of lateral E/e' ratio; (C) TDI of septal/medial mitral annulus and estimation of medial E/e' ratio; (D) Pulmonary venous pulse wave Doppler examination and estimation of S/D ratio

CONCLUSION

The index case highlights the limitation of conventional TDI and Doppler-based assessment of LV diastolic function by intraoperative TEE to quantify the LV filling pressure in this particular disease alongside other limitations like angulations and artifactual error. Therefore, this is an attempt to familiarize with the echocardiographic lexicon “annulus reversus-paradoxus.”

ORCID

Rohan Magoon <https://orcid.org/0000-0003-4633-8851>

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