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TISSUE DOPPLER ECHOCARDIOGRAPHY IN THE ASSESSMENT OF CONSTRICTIVE PERICARDITIS: DIAGNOSTIC INSIGHTS AND CLINICAL PATTERNS

Cardiology

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ABSTRACT

Background: Constrictive pericarditis (CP) can be difficult to distinguish from other cardiac abnormalities. Tissue Doppler imaging (TDI) offers a non-invasive method to assess myocardial relaxation and annular motion. It offers potential to differentiate CP from other cardiac pathologies. **Objective:** To evaluate the diagnostic role of TDI in patients referred for suspected constrictive pericarditis and to characterize the regional annular velocity patterns that distinguish CP from restrictive myocardial diseases and other cardiac abnormalities. **Methods:** The test group comprised 40 consecutive patients referred for echocardiographic evaluation to establish or rule out CP. 20 age- and sex-matched healthy controls were taken for comparison. All patients underwent comprehensive transthoracic echocardiography with tissue Doppler analysis of mitral and tricuspid annuli. Systolic (Sa), early diastolic (Ea), and late diastolic (Aa) velocities were recorded and compared across groups.**Results:** Mitral annular Ea (>8 cm/s) and Sa (>6 cm/s) were preserved in 89.2% of CP patients. In contrast, Ea was reduced in 71.4% of RCM patients. Multi-site preservation of Ea and Sa in the mitral annulus was a distinguishing feature of CP. Septal and inferior annular velocities were the most reliable markers for preserved myocardial function in CP. **Conclusion:**Tissue Doppler imaging provides significant diagnostic value in the evaluation of constrictive pericarditis. Incorporating multi-site TDI assessment into standard echocardiographic protocols can enhance diagnostic accuracy and reduce the need for invasive testing.

KEYWORDS

Constrictive Pericarditis, Restrictive Cardiomyopathy, Tissue Doppler Imaging, Echocardiography

INTRODUCTION

Constrictive pericarditis (CP) is a chronic inflammatory disease in which the pericardium becomes thickened, fibrotic, and calcified. This results in a non-compliant encasement of the heart that restricts diastolic filling (Bhattad, 2020). In early diastole, intraventricular pressures fall normally and leads to a rapid filling of ventricles (Guerra, 2018). But, due to the stiff pericardium, this filling stops abruptly once the volume hits the pericardial constraint. It is an important and a potentially reversible cause of right heart failure (Ahmad, 2025).

CP is one of the few cardiac conditions for which surgical intervention (pericardiectomy) can result in dramatic clinical improvement (Hemmati, 2017). However, the diagnosis of CP remains challenging due to its heterogeneous presentation. A routine 2D echocardiography may not always reveal pericardial thickening or characteristic septal motion (Novak, 2017).

Advanced echocardiographic techniques like tissue Doppler imaging (TDI), have significantly enhanced our ability to diagnose CP non-invasively (Al-Biltagi, 2013). Doppler allows the assessment of respiratory variation in mitral inflow, a hallmark of constrictive physiology (Kadappu, 2007).

Despite the advances, the utility of tissue Doppler echocardiography in routine clinical settings has not been widely reported. This study aims to evaluate the diagnostic role of TDI in patients referred for suspected constrictive pericarditis. We will assess the myocardial and valvular Doppler parameters in these patients to identify consistent patterns and potential diagnostic markers of CP. Additionally, the study will compare the findings in patients who are ruled out for CP, to explore how these parameters behave for other cardiac conditions.

MATERIALS AND METHODS

Study Population

This prospective observational study was conducted in the Department of Cardiology at G.B. Pant Hospital, New Delhi. The study protocol was reviewed and approved by the institutional ethics committee. All the participants provided informed consent.

The study population comprised of 60 individuals, divided into two groups:

- **Patient group (n = 40):** Forty consecutive patients referred to the echocardiography laboratory for the evaluation of suspected constrictive pericarditis.
- **Control group (n = 20):** Age- and sex-matched healthy volunteers without known cardiovascular or systemic disease.

Echocardiographic Examination

All subjects underwent comprehensive transthoracic echocardiography using a commercially available ultrasound system (System Five, General Electric, Horten, Norway). The system was equipped with TDI capabilities.

Parameters assessed in 2D imaging included pericardial anatomy, septal bounce, inferior vena cava (IVC), left ventricular ejection fraction (LVEF). Pulsed-wave Doppler was performed with the sample volume placed at the mitral leaflet tips in the apical four-chamber view.

Tissue Doppler Imaging (TDI)

TDI was conducted using the same transducer by placing a 10-mm sample volume at four mitral annular sites: septal, lateral, anterior, and inferior regions. The following velocities were recorded and averaged over three cardiac cycles:

- Ea (early diastolic annular velocity)
- Aa (late diastolic annular velocity)
- Sa (systolic annular velocity)

STATISTICAL ANALYSIS

Descriptive statistics were used to summarize patient characteristics and echocardiographic findings. Continuous variables were expressed as mean ± standard deviation (SD) and compared between groups using the Student's t-test. Categorical variables were reported as frequencies or percentages and analyzed using the Chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographics

The test group consisted of 40 individuals. Constriction was confirmed in 28 patients at surgery. The underlying cause of constrictive pericarditis was tuberculosis in 15 patients (53.57%), pyogenic in 2, postradiation in 2, and unknown for the 9.

Among the patients that were ruled out for CP, 7 were diagnosed with restrictive cardiomyopathy (RCM) and remaining 5 had other cardiac findings, including prior pericardial effusion or post-surgical pericardial changes.

The mean age across groups was similar (CP: 47.1 ± 12.3 years; RCM: 44.8 ± 11.2 years; Controls: 45.5 ± 10.5 years; P = 0.62). Male predominance was noted in both patient groups (CP: 60.7%; RCM:

57.1%), while the control group had an equal male-to-female distribution.

2D Echocardiographic Findings

Patients with constrictive pericarditis demonstrated a significantly higher incidence of septal bounce (79.3% vs. 0%; P < 0.001), and IVC dilation with absent inspiratory collapse (96.4% vs. 42.8%; P < 0.001) compared to those with RCM. Left ventricular systolic function was generally preserved in CP (mean LVEF: 59 ± 4%), whereas RCM patients had mildly reduced systolic function (mean LVEF: 53 ± 7%; P = 0.03). Only 3 CP patients had reduced LVEF, which was attributable to radiation exposure or extensive annular calcification.

Tissue Doppler Imaging Findings

Mitral Lateral Annulus

In patients with constrictive pericarditis, the tissue Doppler velocities at the lateral mitral annulus demonstrated preserved systolic and early diastolic function in most cases. Ea values were consistently above 8 cm/s, and Sa values exceeded 6 cm/s in most patients (Table 1).

Table 1: Tissue Doppler Velocities: Lateral Annulus

Features	Subject by diagnosis			
	Constrictive Pericarditis (n=28)	Restrictive cardiomyopathy (n=7)	Others (n=5)	Controls (n=20)
Ea cm/s	12.92 ± 3.06	5.60 ± 1.98	15.06 ± 2.63	14.14 ± 1.84
Aa cm/s	8.03 ± 2.45	4.89 ± 1.93	8.06 ± 0.4	7.94 ± 1.17
Ea/Aa cm/s	1.66 ± 3.37	1.19 ± 0.22	1.87 ± 0.31	1.81± 0.32
Sa cm/s	10.08 ± 2.72	5.46 ± 0.39	13.96 ± 5.30	14.72 ±2.63

Mitral Septal Annulus

Septal annular velocities were uniformly preserved among constrictive pericarditis patients. Ea velocities consistently remained above 8 cm/s, and Sa velocities exceeded 6 cm/s in all but one patient (Table 2).

Table 2: Tissue Doppler Velocities: Septal Annulus

Features	Subject by diagnosis			
	Constrictive Pericarditis (n=28)	Restrictive cardiomyopathy (n=7)	Others (n=5)	Controls (n=20)
Ea cm/s	13.24 ± 3.47	7.89 ± 1.47	13.46 ± 2.25	12.93 ± 3.29
Aa cm/s	8.59 ± 2.61	6.01 ± 1.37	9.42 ± 1.03	8.44 ± 2.14
Ea/Aa cm/s	1.65± 0.61	1.33 ± 0.8	1.46 ± 0.37	1.53± 1.54
Sa cm/s	10.05 ± 2.55	5.74 ± 0.66	12.96 ± 1.41	12.64 ±3.19

MITRAL INFERIOR ANNULUS

The inferior wall velocities also reflected preserved myocardial function in most CP patients, with Ea values remaining above diagnostic thresholds and Sa values falling within normal ranges (Table 3).

Table 3: Tissue Doppler Velocities: Inferior Wall

Features	Subject by diagnosis			
	Constrictive Pericarditis (n=28)	Restrictive cardiomyopathy (n=7)	Others (n=5)	Controls (n=20)
Ea cm/s	14.61 ± 4.15	7.83 ± 1.16	17.02 ± 1.98	16.00 ± 1.88
Aa cm/s	8.11 ± 2.67	6.17 ± 1.29	9.22 ± 1.29	9.43 ± 3.12
Ea/Aa cm/s	1.96 ± 0.76	1.30 ± 0.23	1.88 ± 0.36	1.90± 0.71
Sa cm/s	9.72 ± 2.06	5.53 ± 0.29	8.98 ± 1.16	10.24 ±2.42

MITRAL ANTERIOR ANNULUS

At the anterior mitral annulus, tissue Doppler velocities again demonstrated preserved diastolic and systolic function in nearly all CP cases. Ea values remained above 8 cm/s, mirroring the patterns seen at the septal and inferior annuli. Sa velocities were consistently greater than 6 cm/s, indicating intact longitudinal contraction (Table 4).

Table 4: Tissue Doppler Velocities: LV Anterior Wall

Features	Subject by diagnosis			
	Constrictive Pericarditis (n=28)	Restrictive cardiomyopathy (n=7)	Others (n=5)	Controls (n=20)
Ea cm/s	15.61 ± 4.23	8.19 ± 1.86	20.68 ± 4.20	20.31 ± 4.8
Aa cm/s	8.34 ± 2.18	6.97 ± 1.18	11.66 ± 3.03	10.08 ± 3.12
Ea/Aa cm/s	1.97 ± 0.75	1.17 ± 0.12	1.82 ± 0.41	2.14± 0.68
Sa cm/s	11.56 ± 3.08	5.57 ± 0.55	11.66 ± 2.73	12.56 ±2.75

Right Ventricular Free Wall

Unlike the consistent preservation of mitral annular velocities, the right ventricular (RV) free wall annulus showed more variable findings in CP patients. Only 12 of 28 patients (42.8%) had normal or elevated tricuspid Ea (>14 cm/s) and Sa (>12 cm/s). The remaining 16 patients (57.1%) demonstrated reduced RV annular velocities. The 3 CP patients who exhibited reduced mitral annular Ea also had impaired tricuspid annular velocities (Table 5).

Table 5: Tissue Doppler Velocities: Right Ventricle

Features	Subject by diagnosis			
	Constrictive Pericarditis (n=28)	Restrictive cardiomyopathy (n=7)	Others (n=5)	Controls (n=20)
Ea cm/s	14.11 ± 2.92*	10.18 ± 2.63*	17.22 ± 3.18	15.68 ± 6.68
Aa cm/s	8.11 ± 2.67	8.23 ± 2.5	9.22 ± 1.29	13.09 ± 3.89
Ea/Aa cm/s	1.96 ± 0.76	1.19 ± 0.27	1.88 ± 0.36	1.35± 0.93
Sa cm/s	9.72 ± 2.06*	7.10± 1.91*	16.10 ± 2.51	14.10 ±2.62
*P value<0.01				

Restrictive Cardiomyopathy Group

Among the 7 patients with restrictive cardiomyopathy, mitral annular Ea was reduced in five (71.4%), with diminished values evident in at least one annular region. Two patients, one with endomyocardial fibrosis and one with idiopathic myocardial fibrosis, retained normal Ea at either the septal or lateral annulus. But neither exhibited the consistent multi-regional preservation seen in CP. Additionally, tricuspid annular velocities were less frequently impaired in RCM than in CP.

DISCUSSION

This study demonstrates that TDI parameters provides robust discriminatory power for diagnosing constrictive pericarditis. While several of these findings have been described previously, our results underscore their value in real-world, mixed-population settings and provide direct comparison with RCM, a critical mimicker of CP.

Septal Bounce and Interventricular Dependence

The most consistent and earliest echocardiographic signs of CP is the respiration-related interventricular septal shift, or "septal bounce" ‘Welch et al., 2007). In our study, this was observed in 79.3% of CP patients but in none of the RCM or control cases. This is pathognomonic of CP and distinguishes it from RCM. Our septal bounce rate (~80%) is consistent with prior studies, including Park et al., 2014who reported prevalence ranging from 70–90%.

Respiratory Variation in Mitral Inflow Velocities

Respiratory variation in mitral inflow E velocity >25% was highly prevalent (85.7%) in our CP patients and absent in most RCM and all control subjects. This variation reflects the dissociation of intrathoracic and intracardiac pressures in CP. In contrast, in RCM, the myocardium is intrinsically stiff, but pressure transmission remains normal, leading to relatively constant transmitral flow throughout respiration.

A study by Ha,2007 reported mean respiratory E velocity variation of 30–55% in CP and <5% in RCM. Our results align with these findings. Though the slightly higher variation in our RCM group reflect the inclusion of mixed etiologies or post-effusive cases.

Preserved or Increased Mitral Annular Velocity: Tissue Doppler as a Discriminator

The clearest separation between CP and RCM emerged in the mitral annular Ea velocity. Nearly 90% of CP patients had Ea >8 cm/s, indicating preserved longitudinal relaxation, whereas 71% of RCM patients had diminished Ea (<8 cm/s), consistent with myocardial fibrosis or infiltration. This difference is because in CP the myocardium is typically normal, and thus early diastolic recoil (reflected by Ea) is preserved. Conversely, RCM represents primary myocardial disease, such as amyloidosis or endomyocardial fibrosis, where myocardial compliance and relaxation are intrinsically reduced (Rapezzi et al,.2022)

Tricuspid Annular Velocity and Biventricular Analysis

Interestingly, tricuspid annular Ea velocity <14 cm/s was observed in 57% of CP patients in our study, suggesting right ventricular involvement in more advanced cases. This is not classically emphasized in literature, where RV function is considered relatively preserved in CP. These results suggest that biventricular TDI assessment could enhance diagnostic sensitivity in borderline cases or in chronic CP.

Pericardial Thickening and IVC Findings: Nonspecific but Supportive

Only 10.7% of CP patients in our study showed overt pericardial thickening or calcification, highlighting that CP is a functional diagnosis, not an anatomical one. CT or MRI may improve detection, but echo alone cannot exclude CP based on pericardial morphology. On the other hand, IVC plethora, defined as a dilated IVC with <50% inspiratory collapse, was present in 96% of CP patients. While nonspecific (can be seen in many right heart conditions), when combined with other markers, it supports the presence of elevated right-sided pressures (Malik et al.,2020)

Comparison with Restrictive Cardiomyopathy

Distinguishing CP from RCM is clinically imperative, as the treatment strategies diverge sharply. CP is potentially curable with pericardiectomy, while RCM requires lifelong medical management (Rajagopalan et al.,2001). In our study, RCM patients consistently lacked septal bounce, had diminished mitral Ea, and minimal respiratory variation in mitral inflow. These findings reinforce that TDI is the most powerful non-invasive tool to differentiate myocardial vs. pericardial pathology. The limitations of the present study include small sample size which may affect the generalizability of the findings across diverse populations. Additionally, the study was conducted at a single center, which may introduce institutional biases related to patient referral patterns, imaging protocols, or clinical interpretation standards.

CONCLUSION

Constrictive pericarditis remains a diagnostic challenge in clinical cardiology due to its overlapping presentation with restrictive cardiomyopathy and other causes of right heart failure. This study underscores the diagnostic value of tissue Doppler imaging as a readily available, cost-effective, and non-invasive method to delineate pericardial from myocardial pathophysiology.

Supplementary

Table 1. Summary of Demographic and Clinical Data

Features	Subject by diagnosis			
	Constrictive Pericarditis (n=28)	Restrictive cardiomyopathy (n=7)	Others (n=5)	Controls (n=20)
Age (yrs)	24 ±12	29 ± 8	27 ± 10	20 ±12
Men	15	3	2	11
NYHA Class	2.0 ± 0.7	2.7 ± 0.8	1.3 ± 0.2	-
Atrial fibrillation	2	2	-	-
Ejection fraction	59 ± 4	53 ± 7	58 ± 8	62 ±3

Figure 2: Mitral annular velocities in a normal individual

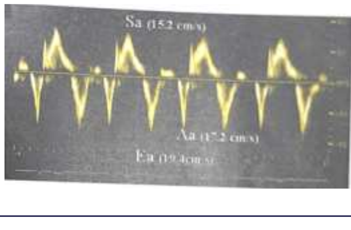


Figure 3: Mitral annular velocity in a 35-year-old male with constrictive pericarditis. Ea velocity was accentuated.

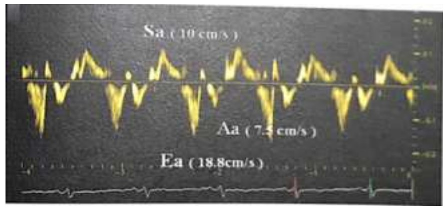


Figure 4: Markedly attenuated early diastolic tricuspid annular velocities in patient with CCP

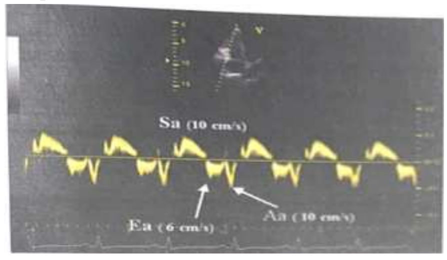
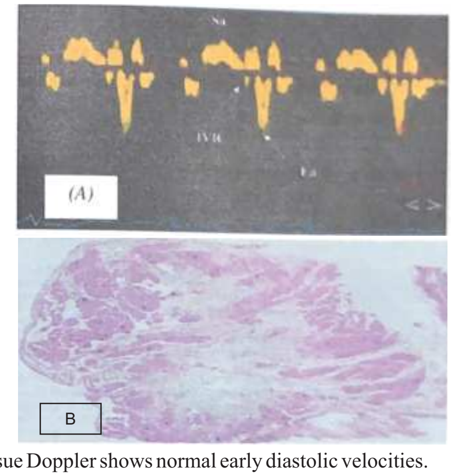


Figure 4: Patient with restrictive cardiomyopathy (biventricular endomyocardial fibrosis)



A. Tissue Doppler shows normal early diastolic velocities.
B. Subsequently, idiopathic restrictive cardiomyopathy was diagnosed based on endomyocardial biopsy specimen.

REFERENCES

1. Bhattad, P. B., & Jain, V. (2020). Constrictive pericarditis: a commonly missed cause of treatable diastolic heart failure. *Cureus*, *12*(5).
2. Guerra, M. (2018). Relevance of intraventricular pressure gradients in left ventricular diastolic and systolic function: clinical implications. *Revista Portuguesa de Cirurgia Cardio-toracica e Vascular: Orgao Oficial da Sociedade Portuguesa de Cirurgia Cardio-toracica e Vascular*, *25*(1-2), 19-26.
3. Ahmad, F. A. J., Abdi, S. I. A., Verma, T., Barsinge, T., Echeverry, W. M. B., Sampath, N., & Khan, S. (2025). A comprehensive review of effusive-constrictive pericarditis, diagnosis, and management. *Cardiology in Review*, 10-1097.
4. Hemmati, P., Greason, K. L., & Schaff, H. V. (2017). Contemporary techniques of pericardiectomy for pericardial disease. *Cardiology clinics*, *35*(4), 559-566.
5. Novak, I., Morgan, C., Adde, L., Blackman, J., Boyd, R. N., Brunstrom-Hernandez, J., & Badawi, N. (2017). Early, accurate diagnosis and early intervention in cerebral palsy: advances in diagnosis and treatment. *JAMA pediatrics*, *171*(9), 897-907.
6. Al-Biltagi, M. (2013). Atrial Function and Glutathione in Children with Iron Deficiency Anemia-Tanta-Egypt-2012. *International Blood Research & Reviews*.
7. Kadappu, K. K., & Thomas, L. (2015). Tissue Doppler imaging in echocardiography: value and limitations. *Heart, Lung and Circulation*, *24*(3), 224-233.
8. Welch, T. D., Ling, L. H., Espinosa, R. E., Anavekar, N. S., Wiste, H. J., Lahr, B. D., ... & Oh, J. K. (2014). Echocardiographic diagnosis of constrictive pericarditis: Mayo Clinic criteria. *Circulation: Cardiovascular Imaging*, *7*(3), 526-534.
9. Park, J. H. (2014). Incidence and fate of the abnormal septal motion after open heart surgeries. *Journal of Cardiovascular Ultrasound*, *22*(1), 6-7.
10. Ha, J. W., Oh, J. K., Ommen, S. R., Ling, L. H., & Tajik, A. J. (2002). Diagnostic value of mitral annular velocity for constrictive pericarditis in the absence of respiratory variation in mitral inflow velocity. *Journal of the American Society of Echocardiography*, *15*(12), 1468-1471.
11. Rapezzi, C., Aimo, A., Barison, A., Emdin, M., Porcari, A., Linhart, A., & Sinagra, G. (2022). Restrictive cardiomyopathy: definition and diagnosis. *European heart journal*, *43*(45), 4679-4693.
12. Malik, A., Chaudhry, M., Abdullah, M., Inam, S. H. A., & Iqbal, N. (2020). Idiopathic dilatation of inferior vena cava: A case report. *Cureus*, *12*(9).
13. Rajagopalan, N., Garcia, M. J., Rodriguez, L., Murray, R. D., Apperson-Hansen, C., Stugaard, M., & Klein, A. L. (2001). Comparison of new Doppler echocardiographic methods to differentiate constrictive pericardial heart disease and restrictive cardiomyopathy. *The American journal of cardiology*, *87*(1), 86-94.