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Clinical And Echocardiography Outcomes Following Pericardiectomy In Chronic Constrictive Pericarditis

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Abstract:
Introduction: *Leading cause of chronic constrictive pericarditis differs according to geographic location, tuberculosis remains the most common cause of constrictive pericarditis in Africa and Asia where as in western country it remains a rare entity and idiopathic causes remains the most common etiology. Here our aim was to study the clinical and echocardiography outcomes post pericardiectomy & compare it with other previous clinical studies.*
Methods: *This is a retrospective study of 12 months with mean follow up period of 2.40 ± 2.01 years. PHILIPS EPIQ7C machine was used for echocardiographic analysis. Mitral and tricuspid inflow velocities were detected using PW doppler in apical 4-chamber view with sample volume of 2-4 mm.*
Results: *All the patients in the study population presented with dyspnea 19(100%). Annulus reversus was observed in all our patients (19, 100%), which resolved completely postoperatively. Mean duration of hospital stay was 26.63 ± 13.09 days with mean ICU stay of 5.89 ± 2.4 days.*
Discussion: *Different from international studies, we observed pericarditis in younger age group with mean age of 26.58 ± 11.9 years which could be accountable to Tuberculosis in young generation in India, as also observed by other indian studies. In our study, there was significant respiro-phasic variation in the mitral and tricuspid E velocity in all patients.*
Conclusions*: Studies on detailed echocardiographic evaluation in terms of various parameters like mitral and tricuspid E velocities and tissue doppler imaging are sparce. This study adds to the important role of echocardiography in assessment of chronic constrictive pericarditis.*
Key-words: *Chronic constrictive pericarditis, Mitral E velocity, Echocardiography, pericardiectomy*

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I. Introduction

Chronic constrictive pericarditis is characterized by restricted diastolic filling of the ventricles that is caused by thickening, fibrosis and calcification of the pericardium with or without myocardial fibrosis or atrophy.[1] Leading cause of this differs according to geographic location, tuberculosis is most common cause of constrictive pericarditis in African & Asian countries where as in western countries it remains a rare entity and idiopathic causes remains the most common etiology.[2,3] As many as 30-60% of patients with tuberculous pericarditis develop chronic constrictive pericarditis as complication.[4] Echocardiography aids in the diagnosis and appropriate management of constrictive pericarditis. However, there is paucity of data in terms of clinical outcome and echocardiography parameters post-pericardiectomy in India. Therefore, this study was aimed to assess the clinical outcome & echocardiographic features pre- and post-pericardiectomy.

II. Material And Methods

This is a retrospective study of 12 months from May 2023 to May 2024 in department of cardiothoracic and vascular surgery. The mean followup period was 2.40 ± 2.01 years. Ethical code of Helsinki was followed and consent was obtained from all patients. The data of all patients who underwent pericardiectomy for chronic constrictive pericarditis between January-2018 to February 2023 were accessed. The clinical presentation along with the New York Heart Association (NYHA) functional class and echocardiographic evaluation was done at least 30 days prior and 3 months following pericardiectomy were

recorded. Preoperatively, cardiac catheterization was performed in two patients due to initial diagnostic ambiguity & Cardiac computed tomography was performed in all patients.

PHILIPS EPIQ7C machine was used for echocardiographic analysis with phased array sector probe of 2-4 MHz. Left ventricular ejection fraction (%) was calculated by 2D echocardiography.[5] Left atrium anteroposterior diameter was measured in Parasternal long axis view.

Mitral and tricuspid valve regurgitation were graded as mild, moderate and severe. The diameter and respirophasic variation of inferior vena cava (IVC) and septal bounce was recorded using M mode.

Mitral and tricuspid inflow velocities were detected using PW doppler in apical 4-chamber (A4C) view with sample volume of 2-4 mm. The peak E velocities obtained by assessing mitral and tricuspid inflow region during both phases of respiration clinically Figure 1 and Figure 2. Tissue Doppler imaging in A4C in early diastole at septal (medial e') and lateral (lateral e') corner of mitral annular plane was used to measure peak annular velocities as shown in Figure 3.

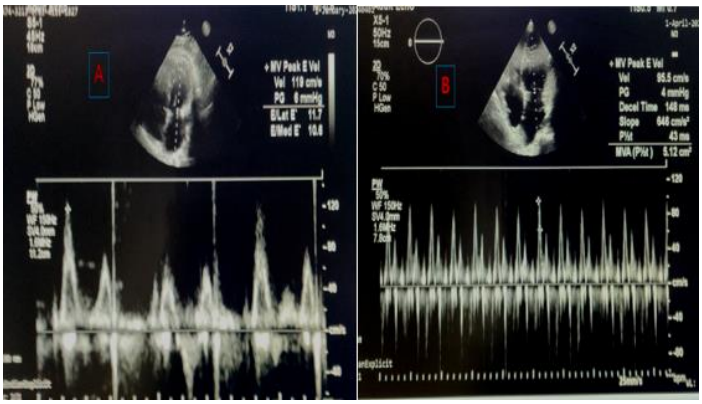

Figure 1: showing Significant respiratory variation in Mitral inflow region Preoperatively (A) & post operatively (B).

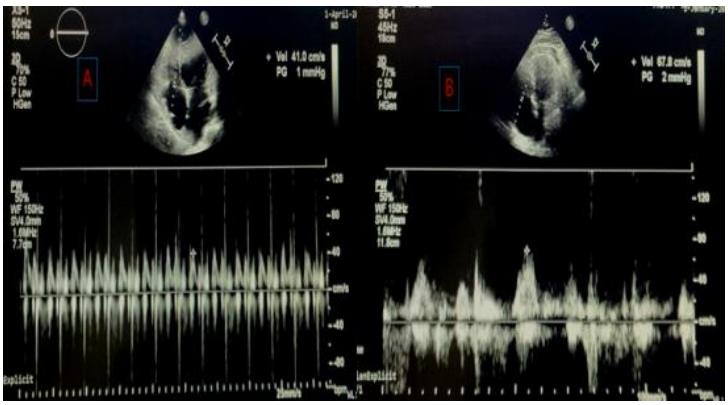

Figure 2: showing Significant respiratory variation in Tricuspid inflow region Preoperatively (A) & post operatively (B).

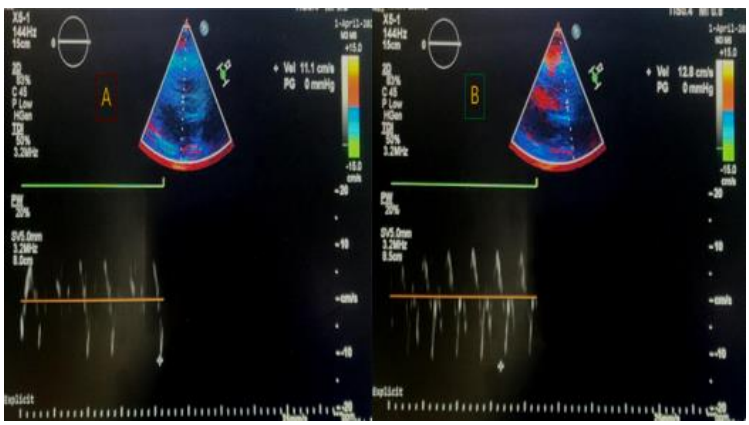

Figure 3: shows Annulus reversus phenomenon observed post pericardiectomy

All patients underwent isolated pericardiectomy through Median sternotomy without cardiopulmonary bypass (CPB) machine & perfusionist on standby, except in one patient where CPB was instituted for intraoperative hypotension. External debfrillator pads were standby in all cases. Intraoperatively & post operatively, central venous pressure (CVP) was monitored.
Patients with tuberculosis have completed anti tubercular therapy as per latest guideline before surgery.

Statistical analysis

Statistical Package for Social Sciences (SPSS) version 25.0, IBM manufacturer, Chicago, USA was used for data analysis. The categorical variables were presented in the form of number and percentage (%). On the other hand, the quantitative data were presented as mean ± standard deviation (SD) and median with 25^{th} and 75^{th} percentiles (interquartile range).

The data normality was checked by using Shapiro-Wilk test. The following statistical tests were applied for the results:
1. Paired t test was used for the comparison of the quantitative variables across the follow-up.
2. Bhapkar test or McNemar test were used for the comparison of the qualitative variables between pre and post echocardiography.
A P value of < 0.05 was considered statistically significant.

III. Result

We studied 19 patients with demographic characteristics as shown in Table 1.

Table 1: Demographic characteristics distribution.

Demographic characteristics	Frequency	Percentage
Gender		
Female	5	26.32%
Male	14	73.68%
History of TB		
No	3	15.79%
Yes	16	84.21%
Age(years)		
Mean ± SD	26.58 ± 11.9	
Median (25th-75th percentile)	23(19-29)	
Range	13-56	

All the patients in the study population presented with dyspnea 19(100%). Ascites and pedal edema were seen in 16(84.21%) and 13(68.42%) patients. However, few presented with palpitation 6(31.58%) and atypical chest pain 4(21.05%). Pericardial calcification was seen in 30% of patients on chest radiography and mean pericardial thickness on mediastinal computed tomography was 5.4 ± 1.3 mm. Improvement in New York Heart Association (NYHA) functional class post-pericardiectomy were shown in Table 2.

Table 2: New york Heart Association class

NYHA class	Preoperative	Postoperative
I	0 (0%)	16 (84.21%)
II	3 (15.79%)	3 (15.79%)
III	10 (52.63%)	0 (0%)
IV	6 (31.58%)	0 (0%)

A comparative analysis of various echocardiography parameters such as Inferior Vena cava congestion, septal bounce, pericardial effusion, tricuspid regurgitation, mitral regurgitation, left atrium size, ejection fraction, mitral E velocity, tricuspid E velocity, mitral annular tissue doppler imaging was performed, pre-pericardiectomy and post- pericardiectomy. (Table 3)

Table 3: Comparison of pre- and post- pericardiectomy echocardiography parameters (n=19)

Parameters	Pre-operative ECHO(n=19)	Post-operative ECHO(n=19)	P value
Inferior vena cava congestion	19 (100%)	2 (10.53%)	<.0001†
Septal bounce	19 (100%)	0 (0%)	<.0001†
Pericardial effusion			
Absent	9 (47.37%)	19 (100%)	0.0005*
Mild	7 (36.84%)	0 (0%)	
Moderate	2 (10.53%)	0 (0%)	

Severe	1 (5.26%)	0 (0%)	
Tricuspid regurgitation			
No	9 (47.37%)	9 (47.37%)	1*
Mild	8 (42.11%)	8 (42.11%)	
Moderate	2 (10.53%)	2 (10.53%)	
Mitral regurgitation			
No	7 (36.84%)	7 (36.84%)	1*
Mild	10 (52.63%)	10 (52.63%)	
Trivial	1 (5.26%)	1 (5.26%)	
Moderate	1 (5.26%)	1 (5.26%)	
Left Atrial size(mm)			
Mean ± SD	39.53 ± 4.87	30.21 ± 4.71	<.0001‡
Median (25th-75th percentile)	39(36.5-42.5)	31(27-31.5)	
Range	31-51	24-45	
Ejection fraction (%)			
Mean ± SD	55 ± 4.00	56.32 ± 4.67	<.0001‡
Median (25th-75th percentile)	55(52-60)	55(55-60)	
Range	50-65	50-65	
Mitral E velocity {Inspiratory}			
Mean ± SD	61.21 ± 5.66	73.26 ± 5.49	<.0001‡
Median (25th-75th percentile)	60(57-65.5)	74(68.5-77.5)	
Range	51-72	65-82	
Mitral E velocity {Expiratory}			
Mean ± SD	91.63 ± 3.82	89.53 ± 6.46	0.215‡
Median (25th-75th percentile)	92(88.5-95)	90(85-94)	
Range	86-97	77-99	
Mitral E velocity {Variation}			
Mean ± SD	30.42 ± 6.78	15.74 ± 3.03	<.0001‡
Median (25th-75th percentile)	31(25.5-35)	16(14-17)	
Range	20-45	10-23	
Tricuspid E velocity {Inspiratory}			
Mean ± SD	88.47 ± 5.67	75.21 ± 5	<.0001‡
Median (25th-75th percentile)	89(84.5-91)	75(72-77.5)	
Range	80-99	67-88	
Tricuspid E velocity {Expiratory}			
Mean ± SD	39.37 ± 5.33	46.95 ± 4.38	<.0001‡
Median(25th-75th percentile)	40(35.5-43)	47(44-50.5)	
Range	31-51	37-54	
Tricuspid E velocity {Variation}			
Mean ± SD	49.11 ± 6.12	28.26 ± 5.91	<.0001‡
Median(25th-75th percentile)	49(45-51.5)	29(23-33.5)	
Range	40-62	18-36	
Mitral annular Tissue Doppler Imaging Medial e'			
Mean ± SD	16 ± 2.33	11.05 ± 1.54	<.0001‡
Median(25th-75th percentile)	16(14.5-18)	11(10-12)	
Range	11-20	8-14	
Mitral annular Tissue Doppler Imaging lateral e'			
Mean ± SD	11.13 ± 2.77	13.95 ± 1.68	0.002‡
Median(25th-75th percentile)	11(9-13.25)	14(13-15)	
Range	7-16	11-18	

‡ Paired t test, * Bhapkar test, † McNemar test

Central venous pressure (CVP) decreased from mean of 31.9 ± 4.89 mmHg preoperatively to 12.95 ±3.84 mmHg in the immediate postoperative period.

Annulus reversus was observed in all our patients (19,100%), which resolved completely postoperatively. Post operative complications are highlighted in Table 4.

Table 4: Post-operative complications distribution.

Post-operative complications	Frequency	Percentage
Reexploration for bleeding	1	5.26%
Low cardiac output syndrome	3	15.79%
Renal failure	1	5.26%
Respiratory insufficiency	3	15.79%
Mediastinitis	1	5.26%

Mean duration of hospital stay was 26.63 ± 13.09 days with mean ICU stay of 5.89 ± 2.4 days.

In hospital mortality was 2(10.53%), both were due to post operative low cardiac output syndrome within 2nd and 4th postoperative day respectively.

IV. Discussion

Although Idiopathic is the most common cause of pericarditis in western world.[6,7] Tuberculosis remains the most common cause of constrictive pericarditis in developing countries like India, which was also seen in our study (84.21%) as found in other local studies.[8,9]

Histopathology study showed pericardial tuberculosis in 91% patients. Constrictive pericarditis is more common in males and our study was consistent with worldwide literature.[7,10,11]

Different from international studies,[12] we observed pericarditis in younger age group with mean age of 26.58 ± 11.9 years which could be accountable to Tuberculosis in young generation in India, as also observed by Jadhao et al.[13] & Patil et al.[9]

The signs and symtoms reported at Mayo clinic were: Heart failure (67%), chest pain (80%),[14] whereas in our study although dyspnea was present in all patients (100%), atypical chest pain was only noted in 21.05% cases which was much lower than mayo clinic.

New york Heart Association class of our patients improved effectively post operatively, as also seen in Ghavidel AA et al.[12]

Increased ventricular interdependence, important hemodynamic feature of chronic constrictive pericarditis, leads to septal bounce and dissociation of intrathoracic and intracardiac pressures leads to exaggerated respiratory variation in mitral and tricuspid inflow velocities.[9] Echocardiography should be the initial investigation of choice. We studied Echocardiographic features as recommended by European Society of cardiology 2015.[15]

The various echocardiographic parameters such as inferior vena cava congestion, mean left atrial size and tissue doppler imaging findings significantly improved similar to a study by Kumar et al [17] and central India[9] post-pericardiectomy. Significant reduction ($p < 0.001$) was noted in inspiratory mitral E velocity without significant change in expiratory mitral E velocity, comparable to Patil et al.[9] In our study, there was significant respiro-phasic variation in the mitral and tricuspid E velocity in all patients ($P < 0.001$). Left atrial size also significantly decreased from 39.53 ± 4.87 mm to 30.21 ± 4.71 mm highlighting improved diastolic filling of heart.

Tissue doppler imaging remain important for differentiating constrictive pathology from restrictive pathology, as annulus reversus (lateral mitral annular e' > medial e') is specific for constrictive pericarditis.[18] We observed annulus reversus in 100 % patients pre surgery, opposed to veress et al (74%).[19]

Table 5 shows comparision of some parameters of our study with one western and one indian study.

Table 5 : Comparision table of this study with western and other indian study

	Our study		Li et al. (n=25)		Patil et al. (n=23)	
Mean age(years)	26.58 ± 11.9		25-78		32.9 ± 15.43	
Gender	M- 14 F- 5		M- 15 F- 10		M - 12 F- 8	
Dyspnea	19 (100%)		22 (88%)		23 (100%)	
Computed Tomography Pericardial Thickness	5.4 ± 1.3 mm		0.61 ± 0.58 cm		5.3 ± 1.1 mm	
Echocardiographic Criteria					n= 20	
	Pre op	**Post Op**	**Pre op**	**Post op**	**Pre op**	**Post op**
1. Congested Inferior Vena cava	19	2	20(80%)		20	3
2. Left Atrial Size (mm)	39.33 ± 10.52	39.33 ± 10.52			39.33 ± 10.52	34.45 ± 10.08
3. Septal Bounce	19	0	20 (80%)		20	5
4. Ejection fraction (%)	50-65	50-65			60	60

5. Change in Mitral E Velocity (%)	30.42 ± 6.78	15.74 ± 3.03	> 25% decrease in 16 patients (80%)		39.23 ± 15.11	14.43 ± 7.76
6. Change in Tricuspid E Velocity (%)	49.11 ± 6.12	28.26 ± 5.91	> 40% increase in 12 patients (60%)		31.33 ± 18.81	17.35 ± 16.26
7. Annulus Reversus	19 (100%)	1 (5.26%)	11 (73%)		12 (60%)	6 (50%)

M - Male F- Female

Median sternotomy is more favourable approach for pericardiectomy, as it allows better exposure, more radical resection and also allows use of cardiopulmonary bypass if needed.

Total pericardiectomy defined as complete resection of pericardium superiorly from innominate vein to diaphragmatic surface inferiorly with lateral margins upto bilateral phrenic nerves.

Although study by voila[20] stood against intracardiac pressure monitoring, we assessed central venous pressure as a marker for adequacy as also done in other studies.

In our study, low cardiac output syndrome (15.79%) and respiratory insufficiency remains the most common complications post operatively as also observed in Zhu et al.[21]

Schwefer et al[22] suggested that long term post-surgery outcome depends not only on surgery but also on etiology and preoperative New york heart association status.

Response to surgery is not immediate and takes a due course, explaining our follow up echocardiography study at least 3 months postoperative.

After pericardiectomy, adverse cardiovascular event free 5 year seen in 70-80% patients and 10 years in 40-50% patients.[25]

In this study population, operative mortality was 10.53% which is in line with international data.[25]

Limitation

The present study is retrospective with small number of patients.

V. Conclusion

Although, tuberculosis being major cause of constrictive pericarditis in asian and African countries is a known fact, this study adds an important role of echocardiographic assessment for chronic constrictive pericarditis.

Pericardiectomy provides very good functional and echocardiographic outcomes. Echocardiography is a valuable tool to assess positive effects of pericardiectomy for chronic constrictive pericarditis.

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