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## **Diagnostic Value of Chest X-ray and Echocardiography for Cardiac Tamponade in Post Cardiac Surgery Patients**

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### **Abstract**

**Objective:** To investigate the effectiveness of X-ray and echocardiography (ECHO) as a diagnostic tool for cardiac tamponade in adult cardiac surgery patients.

**Methods:** Thirty five coronary artery bypass and graft surgery patients who developed cardiac tamponade at Cleveland clinic foundation, were included in this study. Their diagnosis was confirmed at the time of re-exploration in the operating room. These patients were followed retrospectively for demographics, X-ray and echocardiography findings. Abnormal and enlarged cardiac silhouette which was different from first postoperative X-ray was used as radiological criteria for tamponade while echocardiographic diagnosis was left to the discretion of cardiologist.

**Results:** Twenty four males (69%) and 11 (31%) females with an average age of  $60.7 \pm 15.2$  years were included in this study. Only 7 (20%) patients met our criteria for radiological diagnosis of tamponade. All 35 patients showed pericardial effusion on ECHO while cardiac tamponade was present in 30 (86%) patients. Tamponade developed on an average on 4th postoperative day.

**Conclusion:** Radiological diagnosis of cardiac tamponade based on changes in cardiac silhouette provide limited information while ECHO is a reliable diagnostic tool when combined with clinical findings (JPMA 56:104;2006).

### **Introduction**

Cardiac tamponade is a life threatening condition, which nearly always requires urgent and precise therapeutic intervention. Early diagnosis of cardiac tamponade is essential to prevent haemodynamic impairment.<sup>1</sup> Cardiac tamponade following heart surgery is generally due to excessive postoperative bleeding with accumulated clots producing compression of one or more chambers of the heart. Incidence of tamponade varies from 1-5%<sup>2,3</sup> and it remains a major cause of morbidity after cardiopulmonary bypass, necessitating surgical re-exploration in approximately 6% of patients.<sup>4</sup>

Various modalities available for tamponade diagnosis include clinical sign<sup>5</sup> and symptoms, chest X-ray, echocardiography (ECHO) and computed tomography scan, but all these have certain limitations.<sup>6</sup>

Early diagnosis and surgical intervention is of paramount importance to prevent haemodynamic compromise and fatal outcome. Chest X-ray is noninvasive, cheap and easily available diagnostic tool in most of the hospitals. In addition previous X-rays are easily accessible for comparison and early diagnosis. While echocardiography is frequently performed for confirmation of tamponade but still there are concerns<sup>7</sup> regarding its value and early availability in this surgical emergency. Delays are not uncommon in

getting echocardiography results due to non-availability of either machine or technician or cardiologist who can interpret.

The aim of the present study was to retrospectively assess, whether the X-ray and echocardiography are useful in the detection of cardiac tamponade and to see if X-ray can be used as a replacement diagnostic tool in postoperative cardiac surgery patients.

### **Patients and Methods**

We screened all those post cardiac surgery patients who returned to the operating room (OR) for re-exploration or pericardiocentesis for suspected tamponade during the two years period. Only patients coming to OR for relief of tamponade were studied as invasive lines like central and arterial lines could be placed to observe instant changes in haemodynamics after tamponade was relieved. Their medical records, X-ray reports and echocardiography reports were reviewed. Only those patients were included in the study, whose sign and symptoms improved after intervention. Pediatric and non surgical cardiac tamponade patients were excluded.

Records were reviewed for age, sex, type of cardiac surgery, findings on first postoperative X-ray before tamponade, findings on X-ray and echocardiography after development of suspected tamponade and whether signs

improved after intervention.

Abnormal and enlarged cardiac silhouette, which was different from previous postoperative X-ray, was used as radiological criteria for tamponade. Criteria used for diagnosis of tamponade on echocardiography included right atrial and right ventricular collapse along with blunted response of respiration on inferior vena caval plethora. Final diagnosis of cardiac tamponade on echocardiography was left to the discretion of cardiologist. Clinical diagnosis of tamponade considered on the basis of clinical signs which were increased CVP, hypotension, pulsus paradoxus (reduction in systolic blood pressure greater than 12mmHg during inspiration) and oliguria.<sup>8,9</sup>

The statistical analysis was performed by McNemar test, to assess if the proportion of patients positive for tamponade on echocardiography is different from the proportion positive on radiography. P-value less than 0.01 was considered significant. Association between cardiac tamponade and size of effusion diagnosed on echocardiography was also considered for which Fisher's exact test was used.

## Results

Total 35 patients during a two years period met the inclusion criteria. The patient population comprised of 24 males (69%) and 11 females (31%) with an average age of 60.74±15.23 years. Surgical procedure performed on these patients is shown in Table 1.

**Table 1. Type of surgery, ECHO and X-ray findings.**

Type of surgery	No. of patients	Tamponade on ECHO	Change in cardiac silhouette
Coronary artery bypass and grafting (CABG)	08	08	00
Ascending aorta or arch repair	02	02	01
Aortic valve surgery	08	07	03
Mitral valve surgery	06	04	01
Combine aortic valve & CABG	03	03	00
Aortic and Mitral valve	01	0	01
Ascending aorta and aortic valve	01	0	01
Thoracotomy and pericardial window	01	01	00
Mitral valve and CABG	02	02	00
Mitral valve +CABG +aortic valve	01	01	00
ASD repair	01	01	00
Maze procedure	01	01	00
<b>Total</b>	<b>35</b>	<b>30</b>	

Eleven patients had pericardiocentesis and 24 were re-explored for tamponade. The average period for re-exploration was 4th postoperative day.

Seven patients (20%) patients exhibited abnormal and enlarged cardiac silhouette on X-ray after the development of tamponade which was significantly different from first postoperative X-ray (Table 2). None of these X-ray reports mentioned the possibility of tamponade. Interestingly all seven patients were operated for either valve surgery or ascending aorta surgery while no coronary artery and bypass patients showed X-ray changes. Out of these seven patients, six had their ascending aorta opened up for a procedure and one patient had mitral valve surgery.

**Table 2. Radiological findings.**

X-ray findings	No. of patients n= (%)
Abnormal cardiac silhouette on first postoperative X-ray	25 (71%)
Abnormal cardiac silhouette after tamponade	32 (91%)
Change in cardiac silhouette after tamponade	7 (20%)
Pericardial effusion	7 (20%)

All thirty five patients showed pericardial effusion on ECHO, while tamponade was seen in 86% (n=30) of these patients. Five patients did not have tamponade on echocardiography, despite the presence of clinical signs and improvement after intervention. All these five patients had valvular surgery. Large pericardial effusion was present in 65% (n=22) and all these patients had tamponade as well on ECHO (Table 3). Moderate pericardial effusion was present

**Table 3. Association between Cardiac tamponade and size of pericardial effusion\***

Cardiac Tamponade on Echocardiography		Effusion on Echocardiography			Total
		Small	Medium	Large	
Present	Frequency	3	5	22	30
	Percentage	9	15	63	87
	Row %	10	17	73	100
	Column %	75	56	100	
Absent	Frequency	1	4	0	5
	Percentage	3	11	0	14
	Row %	20	80	0	100
	Column %	25	44	0	
<b>Total</b>		<b>4</b>	<b>9</b>	<b>22</b>	<b>35</b>

\*p-value 0.0026 highly significant

ECHO (Table 3). Moderate pericardial effusion was present in 24% (n=9) while 11% (n=4) had a small size effusion.

Comparison between X-ray and echocardiography clearly demonstrated that the proportion of patients positive on X-ray were significantly different from the proportion positive on echocardiography (p-value=0.000).

## Discussion

Pericardial effusion is present in nearly all patients post cardiac surgery. The effusion is frequently asymmetrical or loculated. Cardiac tamponade is an infrequent occurrence post cardiac surgery but requires urgent intervention. Radiological examination is commonly sought for the diagnosis of tamponade but the value of chest X-ray is doubtful in post cardiac surgery patients as pericardium is left open and blood collection is usually regional, further impairing its diagnostic reliability. Majority of patients in our study did not show any change in cardiac silhouette although clinical signs of tamponade were present along with positive ECHO findings. Reasons may be due to loculated nature of post surgical bleeding causing haemodynamic compromise. CABG surgery can make cardiac silhouette abnormal within hours after surgery which not only decreases the sensitivity but also delays the diagnosis by X-ray. This may be the reason that we were unable to find any change in the X-ray in CABG patients. All study patients had their pericardium left open after surgery, which made cardiac silhouette abnormal on X-ray and the diagnosis became very difficult. X-rays taken soon after cardiac surgery showed the presence of abnormal cardiac silhouette in twenty five patients even before these patients developed tamponade. In such situations serial X-rays may be helpful to see any change in abnormal cardiac silhouette along with other clinical evidence.

There are several problems with radiological diagnosis of tamponade. It often shows an enlarged cardiac silhouette when compared with previous films if mediastinal bleeding is present. This is not a sensitive marker however, because presence of mediastinal bleeding does not mean tamponade. Abnormal enlarged cardiac silhouette may suggest the presence of a large effusion but supplies no information about its haemodynamic significance.

Presence of effusion can also give a clue as tamponade is almost always associated with effusion. But it can not be taken as a sensitive indicator because of high incidence of pericardial effusion in post cardiac surgery patients, which is usually reversible and not always associated with tamponade. Another problem is that an abnormal enlarged cardiac silhouette may make it difficult to differentiate on effusion from cardiac dilatation in association with cardiac

failure.<sup>10</sup> The absence of pericardial effusion on ECHO almost always excludes the diagnosis of tamponade but we can not say the same about X-ray. Thirty five study patients had effusion confirmed by ECHO, out of which only seven patients had radiological findings of effusion which shows diminished predictive value of X-ray in diagnosing effusion and tamponade.

There are no X-ray features<sup>11</sup> diagnostic of tamponade, but the presence of abnormal enlarged cardiac silhouette, which is different from previous postoperative X-ray, may give a clue to the diagnosis in the patients suspected of cardiac tamponade. Another clue to the diagnosis of tamponade on plain chest X-ray film would be distortion of the path of a swan ganz catheter<sup>12</sup> due to ventricular compression, which we were unable to find in our patients.

Echocardiography is a reliable noninvasive<sup>13</sup> method for detection of pericardial effusion. As small as 20-50ml of pericardial fluid can be diagnosed by ultrasound.<sup>14</sup> Absence of pericardial effusion usually excludes the diagnosis of tamponade. There is a good correlation between absence of collapse on echocardiography and absence of tamponade.<sup>7</sup>

Studies have shown a high prevalence of atrial collapse in patients with large and moderate effusion, which was also seen in this study when all large pericardial effusion patients showed tamponade on echocardiography, while 50% patients with moderate effusion showed tamponade. Patients who had CABG alone or in combination with valve surgery exhibited tamponade on ECHO, while no change was observed in cardiac silhouette on X-ray. This shows the positive diagnostic value of ECHO and unreliability of X-ray in CABG surgery.

Echogenicity of haemorrhagic effusion especially when clots have been formed may sometimes make delineation of the borders of the pericardium and ventricle wall difficult, compromising the sensitivity of this technique.<sup>15</sup> Two patients in whom tamponade was missed on echocardiography had presence of clots after re-exploration. Sometimes imaging is difficult because of mechanical ventilation in early postoperative period. Those patients in whom diagnosis of tamponade was missed by ECHO had moderate (n=4) and small effusion (n=1) and also these patients developed tamponade in the early period.

In evaluating a patient for tamponade, it is essential to remember that tamponade is a clinical and haemodynamic diagnosis. In a patient with convincing clinical evidence for tamponade, the presence of moderate to large pericardial effusion<sup>16</sup> on echocardiography can help in the diagnosis. But it should also be kept in mind that pericardial effusion after surgery is quite common<sup>17</sup> and it does not always lead

to tamponade. Effusion is usually reversible and not life threatening but sometime it may evolve towards tamponade. On the other hand absence of effusion on ECHO does not always exclude the diagnosis of tamponade as even small amount of clots can produce clinical signs and symptoms and echocardiographic evidence of tamponade. Further studies may need to be done to include all suspected tamponade patients who underwent Pericardiocentesis outside the operating room to make the findings representative.

There is enough evidence to suggest that radiological examination is unreliable for the diagnosis of tamponade due to changes, which appear on X-ray soon after cardiac surgery. Although change in cardiac silhouette or presence of pericardial effusion on X-ray does indicate possibility of tamponade but as shown in this study that radiological diagnosis is difficult and not all these findings are associated with cardiac tamponade.

Echocardiography is a more reliable method than chest X-ray but caution is required in drawing conclusions solely on the basis of echocardiography, as shown by the high number of false negative results in the present study. ECHO does not have 100% predictive value and each finding needs to be considered in conjunction with clinical data.<sup>18</sup>

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