Evolution of the Postoperative Pericardial Effusion After Day 15*

The Problem of the Late Tamponade

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**Study objectives:** To evaluate, through clinical and transthoracic echocardiography (TTE) follow-up, the natural history of persistent pericardial effusion (PE) after postoperative day 15 in patients who were given and were not given anticoagulant therapy.

**Design and patients:** We retrospectively studied a cohort of 1,277 patients who were hospitalized between May 1997 and May 1999 in our center a mean (± SD) time period of 15 ± 3 days after undergoing coronary artery bypass graft (CABG) surgery (856 patients) or valve replacement (VR) surgery (421 patients).

**Measurements:** TTE was performed on mean (± SD) postoperative day 20 ± 1 (TTE1) and postoperative day 30 ± 2 (TTE2). PE severity was classified on a scale from grade 1 to grade 4.

**Results:** On postoperative day 20 ± 1, PE was present in 22% of the 1,277 patients and was more frequent after patients underwent CABG surgery than after undergoing VR surgery (25% vs 17%, respectively; p < 0.01). On postoperative day 30 ± 2, the overall incidence of late tamponade in patients with PE was 4%. The incidence increased with the severity grade of PE at TTE1 (p < 0.001). The negative predictive value of a severity grade < 2 at TTE1 for late tamponade was 100%. Late tamponade incidence was higher after VR surgery than after CABG surgery (11% vs 2%, respectively; p < 0.01), and was higher in patients who had received anticoagulation therapy than in those who had not (8% vs 2%, respectively; p < 0.05).

**Conclusion:** Persisting PE is common after postoperative day 15 and is more frequent after undergoing CABG surgery than after undergoing VR surgery. The incidence of late tamponade is usually underestimated, and it increases with the presence of VR, anticoagulation therapy, and/or higher postoperative TTE severity grade. Our data suggest that only patients with a PE severity grade of ≥ 2 (< 10% of patients) require TTE follow-up after postoperative day 20.

(CHEST 2004; 125:2182–2187)

**Key words:** anticoagulation; cardiac surgery; cardiac tamponade; echocardiography; pericardial effusion

**Abbreviations:** CABG = coronary artery bypass graft; NSAID = nonsteroidal anti-inflammatory drug; PE = pericardial effusion; TTE = transthoracic echocardiography; TTE1 = transthoracic echocardiography performed on postoperative day 20 ± 1 following cardiac surgery; TTE2 = transthoracic echocardiography performed on postoperative day 30 ± 2 following cardiac surgery; VR = valve replacement

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Following cardiac surgery, the incidence of pericardial effusion (PE) is high (range, 50 to 85%) and reaches a peak at the end of the first postoperative week.1-3 The risk of early cardiac tamponade (ie, before postoperative day 15) is well-acknowledged, but the incidence of late cardiac tamponade (ie, later than postoperative day 15) has probably been underestimated.4

Cardiac surgery patients are usually discharged from the hospital around postoperative day 15. Although some of them still have persistent PE that can progress to late tamponade, the natural history of persistent PE after day 15 is not well known. Our postoperative cardiac rehabilitation center allows us to observe patients who have been discharged from the hospital who have persistent PE. Therefore, we...
studied the natural history of persistent PE after postoperative day 15, using clinical and echocardiographic follow-up, in cardiac surgery patients who have and have not received anticoagulation therapy.

**Materials and Methods**

**Patients**

We retrospectively studied a cohort of 1,277 patients (80% men and 20% women; mean age [± SD] 62 ± 12 years) who had been hospitalized in our center a mean of 15 ± 3 days after undergoing cardiac surgery, between May 1997 and May 1999. Eight hundred fifty-six patients had been treated with coronary artery bypass graft (CABG) surgery, and 421 patients had been treated with valve replacement (VR) surgery. The left internal mammary artery had been used for bypass grafting in 99% of CABG patients. Patients who had undergone combined surgery (ie, CABG and VR) were excluded from the study. Aspirin (100 to 300 mg once a day) and oral anticoagulants (fluindion) were routinely administered to CABG and VR patients, respectively. The target international normalized ratio was between 2 and 3.5 for aortic VR, and between 3 and 4.5 for mitral VR, as was recommended at that time in Europe.8

**Echocardiographic Parameters**

An echocardiographic examination was performed (model Vingmed 750; Diasonics Vingmed; Santa Clara, CA) on mean postoperative day 20 ± 1. Transthoracic echocardiography was performed on postoperative day 20 ± 1 following cardiac surgery (TTE1) in all patients. This examination was repeated on mean postoperative day 30 ± 2 (transthoracic echocardiography performed on postoperative day 30 ± 2 following cardiac surgery [TTE2]) in those patients with persistent PE at TTE1.

M-mode, cross-sectional, and Doppler transthoracic echocardiograms were recorded. A standard echocardiographic technique with parasternal (long-axis and short-axis), apical (four-chamber and two-chamber), and subcostal projections was used. Pulsed Doppler echocardiograms of the mitral, aortic, and tricuspid flows were taken from the apical views. We classified PEs into four grades, according to size and site, as follows: grade 1, loculated effusion < 10 mm; grade 2, loculated effusion from 10 to 14 mm or circumferential effusion < 10 mm; grade 3, loculated effusion from 15 to 19 mm or circumferential effusion from 10 to 14 mm; and grade 4, loculated effusion > 19 mm or circumferential effusion > 14 mm (Table 1). PE grade was determined during the diastolic cardiac phase. The diagnosis of cardiac tamponade was based on the following echocardiographic and Doppler signs: right atrial collapse; left ventricular collapse; distention of the inferior vena cava with blunted inspiratory response; and decrease in left ventricular inflow (mitral flow) and outflow (left ventricular outflow tract) velocities. A significant inversion of the right atrial free wall during more than one third of the cardiac cycle was classified as right atrial collapse. Right ventricular collapse was defined as persistent diastolic inversion of the right free wall, noted after the opening of the mitral valve. Left ventricular collapse consisted of an inward early diastolic collapse of the left ventricular free wall. Distension of the inferior vena cava was defined as a decrease of < 35% in the diameter of the proximal inferior vena cava during inspiration, as measured by M-mode echocardiography in a subcostal cross-sectional view during quiet respiration. An inspiratory decrease of > 25% in flows in the mitral and left ventricular outflow tracts was regarded as being significant.10 Subxiphoid pericardiotomy was performed in patients with cardiac tamponade.

**Statistical Analysis**

Data were reported as absolute numbers and frequency percentages, and were compared using a chi-square test with Yates correction when necessary. A p value of < 0.05 was considered to be statistically significant.

**Results**

PE incidence, grade, and distribution on mean postoperative day 20 ± 1, according to the type of surgery, are reported in Table 2. PE was detected in 283 of the 1,277 patients (22%) a mean duration of 20 ± 1 days after surgery and was more frequent after CABG surgery than after VR surgery (25% vs 17%, respectively; p < 0.01).

PE echocardiographic follow-up is reported in Figure 1 and Table 3. Among the 1,277 patients, 107 (8%) had persistent PEs on mean postoperative day 30 ± 2. Late cardiac tamponade developed in 1% of all cardiac surgery patients, but in 4% of those who had persistent PEs on mean postoperative day 20 ± 1. The incidence of late cardiac tamponade significantly increased, with the PE echocardiographic grade of severity determined on mean postoperative day 20 ± 1 (grade 1, 0%; grade 2, 7%; grade 3, 17%; grade 4, 6%)

| Table 2—Incidence and Grade of PE at TTE1* |
| Variables | Total (n = 1,277) | CABG (n = 856) | VR (n = 421) |
| No PE | 994 | 646 (75)† | 348 (83) |
| PE | 283 | 210 (25)† | 73 (17) |
| Grade 1 | 176 | 135 (64) | 41 (56) |
| Grade 2 | 80 | 57 (27) | 23 (31) |
| Grade 3 | 20 | 15 (7) | 5 (7) |
| Grade 4 | 7 | 3 (2) | 4 (6) |
| Tamponade | 0 | 0 | 0 |

*Values given as No. (%).
†p < 0.01.
The objectives of the present study were as follows: (1) to evaluate the incidence of late cardiac tamponade in patients with persistent PE after postoperative day 15; (2) to evaluate the contribution of transthoracic echocardiography (TTE) in predicting the occurrence of late cardiac tamponade; and (3) to evaluate the role of anticoagulant therapy in the development of late cardiac tamponade.

Our results indicate the following: (1) persistent PE is common after postoperative day 15 (22% of patients) and is more frequent after CABG surgery than after VR surgery; (2) the incidence of late cardiac tamponade is significantly increased in pa-

**Table 3—Grade of PE at TTE₂***

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total No.</th>
<th>CABG</th>
<th>VR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td>127</td>
<td>53</td>
</tr>
<tr>
<td>Grade 1</td>
<td>108</td>
<td>81 (64)</td>
<td>27 (51)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>38</td>
<td>29 (23)</td>
<td>9 (17)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>14</td>
<td>10 (8)</td>
<td>5 (9)</td>
</tr>
<tr>
<td>Grade 4</td>
<td>8</td>
<td>3 (2)</td>
<td>5 (9)</td>
</tr>
<tr>
<td>Tamponade</td>
<td>12</td>
<td>4 (3)</td>
<td>8 (15)</td>
</tr>
</tbody>
</table>

*Values given as No. (%).

†p < 0.01.

Twenty-one percent of patients with PE were treated with nonsteroidal anti-inflammatory drugs (NSAIDs) [CABG: 49/210, VR: 8/73]. There was no significant association between NSAID therapy and PE changes, as shown by the variation of the mean grade of severity from TTE₁ to TTE₂ (patients treated with NSAIDS, 2.54 ± 0.73 to 2.08 ± 0.8; patients not treated with NSAIDS, 2.21 ± 0.48 to 1.5 ± 1.04; p = 0.2). No patients received clopidogrel in the present study. Thirteen percent of patients with PE received colchicine (CABG surgery, 30 of 210 patients; VR surgery, 7 of 73 patients). No patients without PE received colchicine. There was no significant association between treatment with colchicine and PE changes, as shown by the variation of the mean grade of PE severity from TTE₁ to TTE₂ (patients treated with colchicine, 2.55 ± 0.69 to 1.93 ± 0.92; patients not treated with colchicine, 2.24 ± 0.56 to 1.64 ± 1.15; p = 0.70).

**Figure 1.** Incidence, grade, and outcome of PE from postoperative day 20 ± 1 to postoperative day 30 ± 2.

**Discussion**

Following cardiac surgery, late cardiac tamponade may develop without clear-cut clinical signs. Misleading presentation of this complication may be life-threatening, as it is a cause of delayed diagnosis and treatment. The incidence of late cardiac tamponade (i.e., after postoperative day 15) is not well-known and has probably been underestimated. Kuvin et al reported that 30% of patients with late tamponade had been discharged early from the hospital following surgery and required readmission for emergency treatment of this complication. They emphasized the crucial need for the identification of patients who are at risk of developing late cardiac tamponade.

The objectives of the present study were as follows: (1) to evaluate the incidence of late cardiac tamponade in patients with persistent PE after postoperative day 15; (2) to evaluate the contribution of transthoracic echocardiography (TTE) in predicting the occurrence of late cardiac tamponade; and (3) to evaluate the role of anticoagulant therapy in the development of late cardiac tamponade.

No patients received anticoagulant therapy. This was probably related to an increase in the incidence of PE grade 4 in the latter group (Fig 4). The number of patients with an increase in PE grade from TTE₁ to TTE₂ was higher in the group of patients who had received anticoagulant therapy than in the group that had not (15% vs 5%, respectively; p < 0.05). The incidence of late tamponade at TTE₂ was significantly higher in patients who had received anticoagulant therapy (8 of 98 patients) than in those who had not (4 of 185 patients) [8% vs 2%, respectively; p < 0.05].
tients with a history of VR, of receiving oral anticoagulants, and with TTE grade \( \geq 2 \) on postoperative day 20.

PE was found in 22% of our patients 2 weeks after cardiac surgery. In previous studies, the incidence varied from 53 to 85%,\(^1\,^2\) This discrepancy may be attributable to the greater number of patients who were evaluated in our study and, more importantly, to the later date of echocardiographic evaluation (ie, the 20th postoperative day in the present study). On postoperative day 30 \( \leq 2 \), late cardiac tamponade was found in 1% of all cardiac surgery patients but was found in 4% of patients with PE, which is similar to the incidence of early cardiac tamponade. These

![Graph showing the incidence of late cardiac tamponade on postoperative day 30]

**Figure 2.** Relationship between echocardiographic grade of PE on postoperative day 20 \( \pm 1 \) and the incidence of late cardiac tamponade on postoperative day 30 \( \pm 2 \). There was a strong association between these two parameters \( p < 0.001 \).

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![Graph comparing grade of postoperative PE between patients who had not received anticoagulant therapy (ATC−) and those who had received anticoagulant therapy (ATC+) on postoperative day 20 \( \leq 1 \) (TTE\(_1\)). There was no significant difference between these two groups at TTE\(_1\) according to the distribution of PE grades.]

**Figure 3.** Comparison of grade of postoperative PE between patients who had not received anticoagulant therapy (ATC−) and those who had received anticoagulant therapy (ATC+) on postoperative day 20 \( \pm 1 \) (TTE\(_1\)). There was no significant difference between these two groups at TTE\(_1\) according to the distribution of PE grades.
results are in agreement with those of previous studies. In the present work, the incidence of PE was significantly higher after CABG surgery than after VR surgery. In previous studies, Weitzman et al did not establish a relationship between the incidence of PE and the type of surgery, whereas Pepi et al, in a larger study, reported results similar to ours. The use of the left internal mammary artery for the coronary bypass graft may explain in part the higher incidence of PE after CABG surgery compared to that after VR surgery because of a greater degree of mediastinal bleeding. Conversely, the closure of the pericardial incision wound, which is done after VR surgery, may reduce PE. However, some studies suggest that closure of the pericardium predisposes the patient to tamponade. This surgical procedure and the associated anticoagulant therapy may explain the higher incidence of tamponade observed in the VR group compared to that in the CABG group in the present study.

Although the reported incidence of late postoperative cardiac tamponade is very low (ie, 0.8 to 4% of patients), it would be of great interest to predict the development of such complications among patients with postoperative PE. As no predictive parameter has been proposed until now, we established an echocardiographic classification of PE. This classification of severity into four grades was done on postoperative days 20 ± 1 (ie, TTE1) and 30 ± 2 (ie, TTE2). The present results show a significant association between the PE echocardiographic grade established at TTE1 and the incidence of late tamponade at TTE2, which increased from 0% in grade 1 patients to 43% in grade 4 patients. Thus, the negative predictive value for late tamponade of PE grade < 2 at postoperative day 20 ± 1 equals 100%.

These results suggest that TTE performed on postoperative day 20 can safely separate patients who do not need echocardiographic follow-up (ie, those with PE grade < 2, representing 92% of patients in the present study) from those who require close TTE monitoring (ie, those with PE grade ≥ 2, representing 8% of our patients).

There has been some controversy concerning the role of anticoagulants in the development of PE after cardiac surgery. Merill et al reviewed 16 patients with late postoperative pericardial tamponade, 13 of whom were receiving anticoagulant therapy. These results were in agreement with those of two other studies.
studies. On the other hand, Ofori-Krakye et al reported 10 cases of late cardiac tamponade among 1,290 patients, and only one of those 10 patients was receiving anticoagulant therapy. Two other small studies did not demonstrate a deleterious impact of anticoagulant therapy. In our study, the grade of postoperative PE significantly decreased from TTE₁ to TTE₂ in patients who had not received anticoagulant therapy, whereas it did not significantly change in patients who had received anticoagulant therapy. This suggests a probable worsening of PE from TTE₁ to TTE₂ in patients who have received anticoagulant therapy, as shown by the increase in the incidence of patients with grade 4 PE in this group. As patients who had received anticoagulant therapy were similar to those who had not, according to PE grade distribution at TTE₁, we compared the two groups of patients according to PE grade changes from TTE₁ to TTE₂, and to the incidence of late tamponade at TTE₂. There was no difference in the distribution of PE grades at TTE₂ between the two groups of patients. However, the incidence of late tamponade was significantly higher in patients who had received anticoagulant therapy than in those who had not, despite the fact that therapeutic international normalized ratios were used in the former group, suggests that anticoagulant therapy may be a contributing factor in the development of postoperative cardiac tamponade. This is illustrated by a higher incidence of tamponade in the VR group, who routinely received oral anticoagulants, than in the CABG group, who routinely received aspirin.

In conclusion, the present study validates, for the first time, the use of a TTE classification of postoperative PE for predicting late postoperative cardiac tamponade. According to this classification, only patients with a PE grade ≥ 2, who comprised < 10% of patients in the present study, require echocardiographic follow-up after postoperative day 20. In the other patients (about 90% in the present study), the negative predictive value of PE grade < 2 for late postoperative cardiac tamponade is equal to 100%. These results are important because PE is common, and late tamponade is not rare (1%) following cardiac surgery. PE is more frequent after CABG surgery than after VR surgery.

Finally, the present work shows a strong association between the incidence of late tamponade and both anticoagulant therapy and VR surgery, suggesting that anticoagulant therapy may be a major contributing factor to the development of late postoperative cardiac tamponade. Because of the retrospective design of the present study, the absence of significant effects of other concomitant medications (NSAIDs, colchicine) on the outcome of postoperative PE needs further investigation.

References