Diagnosis, Management, and Clinical Outcome of Cardiac Tamponade Complicating Percutaneous Coronary Intervention

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Cardiac tamponade is an uncommon but life-threatening complication of percutaneous coronary intervention (PCI). The purpose of the present study was to characterize the incidence, management, and clinical outcome associated with this complication. We analyzed a prospective database of 25,697 PCI procedures performed at William Beaumont Hospital (Royal Oak, Michigan) between October 1993 and December 2000. Cardiac tamponade was observed in 31 of 25,697 PCI procedures (0.12%). Cardiac tamponade was diagnosed in the catheterization laboratory in 17 of 31 patients (55%), and 14 patients (45%) had a delayed presentation (mean time from PCI 4.4 hours). Cardiac tamponade was twice as frequent after use of atheroablative devices compared with percutaneous transluminal coronary angioplasty and stenting (0.26% vs 0.11%, p <0.05). All patients with immediate cardiac tamponade had coronary artery perforation. In 11 of 14 patients with delayed tamponade (79%), no actual site of perforation could be identified. A moderate or large pericardial effusion was observed in 20 patients, and 9 had small effusions without typical echocardiographic features of tamponade. Percardiocentesis was performed in 30 patients; 19 patients (61%) were treated successfully with aspiration alone, but 12 patients (39%) required further emergency surgical intervention. In-hospital complications included death (42%), emergency surgery (39%), myocardial infarction (29%), and transfusion (65%). Cardiac tamponade is an uncommon but important complication of PCI and is associated with high mortality and morbidity. Most cases are recognized in the catheterization laboratory, but delayed cardiac tamponade may occur and must be considered as a cause of late hypotension after PCI. ©2002 by Excerpta Medica, Inc.

METHODS

Study population: We identified 31 patients who developed cardiac tamponade during PCI from a large prospective database of 25,697 coronary interventional procedures performed at William Beaumont Hospital (Royal Oak, Michigan) between September 1993 and December 2000. Five patients who developed cardiac tamponade from other causes were excluded from the analysis. These causes included left ventricular free wall rupture complicating acute myocardial infarction (2), wire perforation of the left ventricle while crossing the stenotic aortic valve (1), percutaneous laser myocardial revascularization (1), and concomitant cardiac tamponade and retroperitoneal hemorrhage (1). Coronary interventions included conventional balloon angioplasty (n = 11,336, 44%), stenting (n = 11,653, 45%), mechanical rotational atherectomy (n = 1,812, 7%), directional coronary atherectomy (n = 297, 1%), transluminal extraction atherectomy (n = 453, 2%), and excimer laser angioplasty (n = 129, 0.5%). Clinical, angiographic, and echocardiographic data for each patient with cardiac tamponade were obtained by detailed review of medical records.

Definitions: The diagnosis of cardiac tamponade was based on clinical and/or echocardiographic findings in the absence of other potential causes for hypotension such as myocardial ischemia, hemorrhage, vasovagal reaction, or anaphylaxis. The size of the pericardial effusion by echocardiography was graded as small (≤1/2 cm), moderate (1/2 to 1 cm), or large...
Results

Clinical and angiographic data: Thirty-one patients (mean age 68 ± 13 years) developed cardiac tamponade during or early after PCI. Overall, cardiac tamponade was observed in 31 of 25,697 patients who underwent PCI (0.12%). Most patients with cardiac tamponade were elderly, had multivessel disease, and had complex coronary lesions (26 of 31 had type B2 or C lesions; Table 1). Cardiac tamponade was more frequent with the use of atheroablative devices compared with percutaneous transluminal coronary angioplasty or stenting (0.26% vs 0.11%, p < 0.05; Table 2). The intervention sites are listed in Table 3.

Diagnosis of cardiac tamponade: Cardiac tamponade was diagnosed in the cardiac catheterization laboratory in 17 of 31 patients (55%) (mean time from the start of the PCI was 18 minutes). Fifteen patients had an urgent echocardiogram performed. All patients had a pericardial effusion, but only 9 of 15 patients had a moderate or large effusion. Two patients with rapid clinical deterioration were treated without echocardiography: 1 patient with massive extravasation from coronary artery perforation had emergency pericardiocentesis performed before an echocardiogram was obtained. Another patient had emergency coronary artery ligation and coronary artery bypass grafting without diagnostic echocardiography.

In 14 of 31 patients (45%), cardiac tamponade presented late after coronary intervention (mean time 4.4 hours after PCI, range 2 to 15). The most frequent mode of presentation was progressive hypotension, and in 5 patients this culminated in cardiac arrest.

Causes of cardiac tamponade: All patients with early tamponade had free coronary perforation caused by an interventional device. One patient with tamponade who had emergency surgery performed was found to have a large intramyocardial hematoma, but minimal free pericardial fluid. In the late onset group, 10 of 14 patients had no identifiable cause for cardiac tamponade. Two patients had tamponade due to right ventricular perforation caused by a temporary pacing wire, and 2 had evidence of coronary perforation at the lesion site; however, only 7 patients had repeat coronary angiography performed.

Management of cardiac tamponade: All patients were treated with intravenous volume expanders and inotropic support. Anticoagulation was reversed (mainly with protamine) in 17 patients (12 early, 5 late). Four patients were receiving a glycoprotein receptor inhibitor when cardiac tamponade developed; in all cases therapy was discontinued upon diagnosis.
only (n/H11549/H11549)loon in patients with a coronary perforation, a prolonged bal-
hemodynamic or ventilatory support or transfusion catheterization laboratory were more likely to require
Patients who developed cardiac tamponade in the following percutaneous coronary intervention according to time of
FIGURE 1. Management of patients with cardiac tamponade fol-
clinical outcomes based on the mode of presentation.
Patients who develop cardiac tamponade in the catheterization laboratory almost always have coro-
ary artery bypass graft (n = 9); surgical pericardiocentesis only (n = 3).

Patients who developed cardiac tamponade in the catheterization laboratory were more likely to require hemodynamic or ventilatory support or transfusion than those with a late presentation (Table 4). In all patients with a coronary perforation, a prolonged bal-
loon inflation or perfusion balloon was used, but they sealed the perforation in only 2 patients. Additional treatment for coronary perforation included autolo-
gous vein graft stent in 1 patient and coil embolization with thrombin injection to a vein graft in another patient. Emergency pericardiocentesis was performed in all but 1 patient (97%); in 19 patients the tampon-
ade was treated successfully with aspiration alone, but 12 required emergency surgical intervention (Figure 1). In 1 patient pericardiocentesis was complicated by right ventricular puncture, and in another patient a liver laceration occurred. Two patients went directly to surgery because of severe hemorrhage; 1 of these patients also had an occlusion of the proximal left anterior descending coronary artery.

Clinical outcomes: Cardiac tamponade was associ-
ated with a very high overall mortality rate (13 of 31
patients, 42%), especially for those patients who de-
veloped cardiac tamponade in the cardiac catheteriza-
tion laboratory (mortality 59% for early diagnosis vs
21% for late diagnosis, p = 0.036). Six of 12 patients
(50%) referred for emergency surgical intervention
died. Nine patients (29%) had a myocardial infarction
(Table 5). There was no definite association between
use of a glycoprotein IIb/IIIa inhibitor and cardiac tamponade (cardiac tamponade in 4 of 3,956 [0.1%]
vs no cardiac tamponade in 27 of 21,741 patients
[0.12%]; p = 0.48).

DISCUSSION
In contemporary practice, cardiac tamponade is a rare complication of PCI. The present study represents the largest series of patients with cardiac tamponade complicating PCI and highlights several important aspects relating to diagnosis, management, and clinical outcomes based on the mode of presentation.

Patients who develop cardiac tamponade in the catheterization laboratory almost always have coronary artery perforation. In these patients the diagnosis is usually obvious, but other causes of hypotension such as hemorrhage, ischemia and/or infarction, and anaphylaxis must also be excluded. When cardiac tamponade is suspected, a right atrial catheter should be placed immediately to allow monitoring of central venous pressure, and echocardiography should be performed to confirm the diagnosis. Excessive reliance should not be placed on right-sided cardiac collapse phenomena because these require expertise in interpretation, and time constraints usually limit detailed evaluation and imaging in a critically ill patient. Although most patients have evidence of pericardial effusion, some may have only a small volume of blood in the pericardial space despite profound hemody-
namic instability. In rare cases, intramyocardial hemorrhage may mimic the presentation of tampon-
ade.

In contrast to previous studies, we found that pa-
tients who developed early cardiac tamponade had a very poor prognosis. Almost 1/3 of these patients required emergency surgical intervention, either to repair a coronary laceration or because pericardiocen-
tesis failed to relieve the pericardial tamponade. De-
spite aggressive therapeutic intervention, almost 50% of patients died, regardless of whether the patient was treated with pericardiocentesis alone or had surgical intervention. However, the poor prognosis observed in our study differs from that seen in a recent study by von Sohsten et al. In this series of 6,999 patients who underwent PCI, 15 patients developed cardiac tamponade, but all patients survived the index hospital-
ization. However, in this series, half of the cases were due to right ventricular rather than coronary artery perforation, thus suggesting that the cause of tamponade, and rate of fluid accumulation in the pericardial space, may have an important influence on clinical outcome.
An important finding from the present study is that cardiac tamponade may present several hours after PCI, and in rare cases may not be recognized for up to 24 hours. These late-presenting cases are often a diagnostic challenge at the bedside, and a careful and prompt evaluation must be performed to exclude tamponade. The jugular venous pressure should be estimated and documented on the chart after PCI, and although the patient may remain supine for several hours following the procedure, engagement of the neck veins should be taken as a sign of a possible increase in jugular pressure. In contrast with the early cases, echocardiography is more likely to demonstrate a moderate or large pericardial effusion. Not infrequently, however, the cause for tamponade is unclear even when the patient is taken back to the catheterization laboratory. In these cases tamponade is presumably due to small perforations either at the lesion site, in the distal coronary artery due to guidewire trauma, or right ventricular perforation if a pacing wire was used during the procedure. Because some of these late-presenting cases may be due to small coronary perforations, which are often amenable to percutaneous treatment, we recommend performing coronary angiography in all cases to define the underlying cause for tamponade.

The poor prognosis associated with cardiac tamponade emphasizes the importance of taking steps to prevent this complication, such as careful guidewire advancement and positioning, avoidance of balloon or device oversizing, and meticulous attention to device selection and technique. Care should also be taken with the use of temporary pacing wires, and some investigators advocate the use of balloon-tipped pacing electrodes to reduce the risk of ventricular perforation. Several studies have shown that the use of atheroablative devices is associated with a higher risk of coronary perforation and tamponade; the present study is no exception. If coronary artery perforation does occur during PCI, initial management should focus on sealing the perforation as quickly as possible to prevent accumulation of blood within the pericardial space. Generally, this can be achieved using a prolonged balloon inflation, and if necessary a perfusion balloon catheter to reduce myocardial ischemia. Anticoagulation should be reversed in cases of severe perforation. The introduction of covered stents has been a significant advance, and may avoid the need for surgical intervention in a number of patients with coronary artery perforation. However, in the present study, polytetrafluoroethylene-covered stents were not available, and only 1 patient was treated with a vein-coated stent. Foam or microcoil embolization may also be helpful in selected cases.

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