Diagnosis and Treatment of Acute Cardiac Tamponade by the Subxiphoid Approach

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Emergency cardiac surgery has been performed on 18 cases of acute cardiac tamponade whose etiologies were as follows: 11 cases of metastatic carcinoma, four cases of idiopathic pericarditis and three with other causes. In most cases, the chief complaint was dyspnea. In many cases, the cardiac silhouette of frontal chest X-ray films showed the shape of a water-filled ice-bag placed on a table. The electrocardiogram showed a low voltage and a flat T-wave in approximately half of the patients. In cases of an echo-free space 1 cm or larger on the M-mode echocardiogram, the average amount of pericardial fluid drained was 850 ml and in those in which the space was less than 1 cm, the average drained was 557 ml. The CT values were 9-40 for patients with malignant pericardial effusion and 20-22 for cases of idiopathic pericarditis. In general, pericardiocentesis was performed in almost all the patients with acute tamonade, but if the drainage was inadequate, the subxiphoid pericardial window procedure was performed under local anesthesia. Surgical invasion in this technique was minimal and the operative results proved effective. For the operation, we resected a 2×2 cm pericardial segment. Since two of the patients with malignant pericardial effusion developed postoperative reaccumulation, resection of a 4×4 cm segment in the future has been contemplated.

(Key Words: Cardiac tamponade, Carcinomatous pericarditis, Idiopathic pericarditis, Subxiphoid pericardial window)

INTRODUCTION

Cardiac tamponade is a pathological condition affecting the diastolic filling of the ventricles due to increased intrapericardial pressure. The symptoms are sometimes acute and can be fatal. The first step is to perform pericardiocentesis, but the results are very often unsatisfactory, because insufficient drainage or reaccumulation tends to occur. In emergency cases a subxiphoid pericardial window procedure under local anesthesia has been performed as the first choice.

MATERIALS AND METHODS

Eighteen patients were admitted to Tokai University Hospital for emergency cardiac tamponade during the period between July, 1978 and December, 1982 (Table 1). Most of the patients (11 cases, cases 5 to 15) had malignant pericardial effusion. In cases 6 and 12 the initial symptoms were due to cardiac tamponade and pericardial biopsy or cytology of pericardial

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<table>
<thead>
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<th>No.</th>
<th>Age</th>
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<td>16</td>
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<td>17</td>
<td>19</td>
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CT: Pericardial effusion quantity estimated by CT and CT number
Pericardial effusion: IIIb, and V represent cytological results
*Pericardial window under right thoracotomy because of recurrence.
**Pericardial window under right thoracotomy because of recurrence and left thoracotomy because of second recurrence.
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<table>
<thead>
<tr>
<th>CT</th>
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<td>Effective 2 months</td>
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<td>Hemorrhagic V,750 ml</td>
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<td>Effective 9 months</td>
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<td>Effective 4 months</td>
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<td>Effective 1 months</td>
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<td>Left thoracotomy</td>
<td>Hemorrhagic V,500 ml</td>
<td>Effective 4 months</td>
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<td>Left post 24-25</td>
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<td>Hemorrhagic 310 ml</td>
<td>Effective 13 days</td>
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<td>Right thoracotomy</td>
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<td>Effective</td>
<td>Alive</td>
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Effusion revealed a carcinoma for the first time. The primary sites were identified as the mammary gland in four patients, the lung in three patients, the stomach in two patients, the pancreas in one patient and an unknown origin in one patient.

Idiopathic pericarditis was observed in four patients (Case 1-4) and pathological examination of the pericardial specimen and effusion including a virus examination did not result in identification of the cause.

Chronic renal failure, rupture of the right atrium due to a blunt chest trauma and the postoperative state of open heart surgery were found in one patient each.

CLINICAL SYMPTOMS

The main symptoms that had drawn attention to the cardiac tamponade were dyspnea in twelve patients, an enlarged cardiac silhouette in five patients, discomfort of the chest, edema and paradoxical pulse in four patients, palpitations and hypotension in three patients, and cold sweat and fatigue in two patients.

LABORATORY DATA

Among the patients with idiopathic pericarditis, cases 2 and 3 had markedly enlarged cardiac shadows on the frontal chest film as shown in Figure 1. The best way to describe the enlargement is to liken it to a water-filled ice-bag placed on a table. The cardiothoracic ratios were 80 and 82% respectively. In case 1 (67%) and case 4 (75%), the enlargement of the cardiac shadow was mainly toward the left and only the left cardiac border had a roundsh prominence (Fig. 2).

Fig. 1 Cardiac tamponade caused by idiopathic pericarditis (case 2). The cardiac shadow is likened to a water-filled ice-bag on a table.
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![Cardiac tamponade caused by idiopathic pericarditis. (case 1). Only the left border of the cardiac shadow has a roundish prominence in the shape of an ice-bag.](image)

Six patients with malignant pericarditis showed a cardiac shadow close to the shape of a flask. Of these six patients, two (cases 7 and 13) had a characteristic globular silhouette on the right border (Fig. 3). For the other five patients with malignant pericarditis, it was not possible to establish a characteristic cardiac enlargement, because pleural fluid was present as a complication. Among the 11 patients, 10 had cardiothoracic (C-T) ratios of 63-70%. Only case 9 had a C-T ratio as low as 56%.

The electrocardiograms taken immediately prior to the operation showed sinus tachycardia in 17 patients, a flat T-wave in 11, a low voltage in 10, and ventricular tachycardia, atrial fibrillation, ST-segment depression, ST-segment elevation and left atrial overload in one patient each. In addition six patients had abnormalities that had already been detected such as pacemaker rhythm and left ventricular hypertrophy. A low voltage and a flat T-wave were observed in 56% of the patients.

In four patients with idiopathic pericarditis (cases 1-4) there was an echo-free space in excess of 1 cm on the anterior chest wall, and therefore, massive accumulation was diagnosed. Six patients with malignant pericardial effusion had massive accumulation, while five patients had a medium degree of accumulation (echo free space of less than 1 cm).

In the cases of a medium volume of pericardial effusion, two-dimensional echocardiography revealed an echo-free space extending from the posterior wall of the left ventricle to the apex. In the present of a large volume of effusion, the echo-free space extended evenly around the heart, so that the heart appeared to float within the effusion liquid.
Computed tomography (CT) were performed and CT numbers checked in seven patients. Four patients with malignant effusion showed values of 9-13, 15-17, 19-20 and 40. Two patients with idiopathic pericarditis (cases 2 and 3) had values of 18-26 and 20. Cardiac tamponade after the Bentall operation was 24-25.

PREOPERATIVE MANAGEMENT

The patients with idiopathic pericarditis had pericardial punctures performed one to four times before the operation. Case 2 showed an improved C-T ratio from 80% to 52% after pericardiocentesis. However, within a period of two months to one and a half years after pericardiocentesis, pericardial effusion had recurred repeatedly, thus necessitating surgery.

Among the patients with malignant pericarditis, seven had no pericardiocentesis prior to the operation. One patient underwent the puncture once and three patients were subjected to the puncture three times before the operation. The maximum amount of pericardial effusion drained off was 550ml. Surgical intervention became necessary either on the same day as the pericardial puncture or within an interval of up to four days after the puncture.

The patient with chronic renal failure (case 18) was subjected to puncturing once (with 400ml of effusion drained off) and operated on the following day. Case 16 (after the Bentall operation) and case 17 (blunt chest trauma) were diagnosed as having a cardiac tamponade and operated on immediately.
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SURGICAL PROCEDURE

For emergency cases a subxiphoid pericardial window procedure was selected as the first choice under local anesthesia (Fig. 4). A midline longitudinal skin incision is made from the xiphosternal junction to 8 cm below the tip of the xiphoid. The linea alba is divided. The xiphoid process and the lower edge of the sternum are resected by bone rongeurs to expose the pericardium, which is visualized as a bulging membrane. After resection of a 2 × 2 cm segment in the anterior pericardium, a 28 F silicone tube is placed in the posterior pericardium water-seal drainage. The tube drainage is allowed to continue until the volume of the draining fluid has been reduced to a sufficient level. After removing the tube, the pericardial effusion may be absorbed into the subcutaneous tissue through the pericardial window.

This operation can be performed under local anesthesia and takes only a short time. It is a very valuable technique as an emergency operation for serious cases and elderly patients since it does not require thoracotomy or laparotomy.

Fig. 4 Subxiphoid pericardial window procedure

RESULTS

Among the four patients with idiopathic pericarditis, three underwent the subxiphoid pericardial window procedure and only one patient had pericardial fenestration to the right pleural cavity by a median sternotomy due to suspicion of a cardiac tumor. The volume of the pericardial effusion was 400-1,780 ml. In two patients the fluid was serous and in others hemorrhagic. During the first pericardiocenteses, all patients showed serous effusion. The intermingling of the pericardial fluid with blood during the opera-
tion was therefore attributed to the needle puncture intervention. The pericar
dial tube was allowed to drain for a period of three to four days. The pericar
dium of four patients showed fibrous pericarditis and all virus antibodies were
negative. The results were outstandingly good for all patients and no recur-
rence of pericardial effusion was observed.

In the ten patients of malignant pericardial effusion, subxiphoid pericar
dial window procedure was performed. One of them (case 10) developed apnea
immediately after the operation. Despite various resuscitations, this patient
died possibly as a result of the sudden drainage and insufficient transfusion.
Seven of these 10 patients showed no recurrence of cardiac tamponade prior
to death. However, case 7 (mammary cancer) required a second operation
by pericardial fenestration through a right thoracotomy because effusion
recurred two months after the first operation. Case 12 (lung cancer) also need-
ed a reoperation by pericardial fenestration through right thoracotomy two
months after the first operation and a third operation again through left
thoracotomy two weeks later.

Case 15 (mammary cancer) had pericardial fenestration through left
thoracotomy from the start because left pleural effusion was complicated.

The volume of pericardial fluid drained during the operation was
300-1,300ml for the patients with malignant pericarditis. Nine of these pa-
tients had hemorrhagic effusion and two (case 8 and 9) had serous effusion.
Cytological examination of the pericardial effusion showed class V in three
patients class IIIb in two. In the pericardial biopsy, a malignancy was
discovered in only one patient (case 12). On the basis of this finding (squamous
cell carcinoma), lung cancer was suspected in this patient. The drainage period
averaged 4.8 days with a range of two to nine days.

Three patients with malignant pericardial effusion were treated with
tetracycline instillation into the pericardial cavity and no reaccumulation
was observed. Two patients were treated with mitomycin. One of these (case
7) redeveloped effusion and had to be operated on again. No drug instilla-
tion was performed on six patients, one of whom (case 12) required a second
operation.

The survival period after the pericardial window procedure for malign-
ant pericarditis varied considerably, depending on the development and
progress pattern of the primary disease. In any event, six patients survived
four months or more after the operation, the longest survival period being
11 months (case 8 with pancreatic cancer). None of the patients died as a
direct result of the recurrence of cardiac tamponade.

DISCUSSION

It should be noted that, in most cases in which pericardial effusion oc-
curs with comparative rapidity, dyspnea develops as the major symptom.
About 22% of the patients showed pulsus paradoxus. If one looks more
carefully, this number is bound to be even greater (17).

Chest X-rays of patients with cardiac tamponade are sometimes reported
to show a straight line at the left cardiac border or triangular formation of
the cardiac shadow. None of the 18 patients observed by the authors had
X-ray signs corresponding to the above, and therefore, this X-ray presenta-
tion may not be appropriate. In cases with a large amount of pericardial effusion, the most appropriate description of the roentgenological sign is to liken the condition to a water-filled ice-bag placed on a table. In patients with a medium amount of effusion, the cardiac silhouette may take the shape of a flask. The left and right border are not necessarily symmetrical. It should be noted that in a large number of cases the left superior part of the cardiac shadow assumes a typical curvilinear contour in the shape of an ice-bag or a flask.

The electrocardiograms showed a low voltage and a fat T-wave in 56% of the patients. Therefore, the existence of a cardiac tamponade can not be denied by the absence of these findings.

With the popularization of echocardiography, the diagnosis of pericardial effusion has become accurate and simple. If there is any doubt, it is best to perform echocardiography. The cases in which the maximum width of the echo-free space in M-mode echocardiography were 1cm or more represented large-volume effusion. The amount of fluid drained off during the operatin of these patients was 450-1,780ml, with an average of 850ml. If the maximum width of the echo-free space was less than 1cm, the effusion was considered as being of medium volume. The corresponding amount drained varied between 300 and 1,300ml, with an average of 557ml (Fig. 5). With these diagnostic criteria, a rough estimation can be made of the volume of the pericardial effusion.

According to Gramiak et al.(6), the amount of pericardial effusion drained when the maximum value for the echo-free space was 1cm was 800ml, when it was 1.7cm, 1,000ml was drained, and when it was 2cm, 1,250ml. Horowitz et al. (9) reported a formula for estimating the volume of pericardial effusion based on a calculation derived from the M-mode echo. It should be remembered, however, that cardiac tamponade is not determined by the absolute volume of pericardial fluid. If the rate of accumulation is high and the distensibility of the pericardium is insufficient, clinical symptoms of cardiac tamponade develop. This can be seen clearly from Table 1. Even if the echocardiogram shows medium-volume effusion, immediate treatment will be necessary in cases in which the clinical evidence of cardiac tamponade is clear.

In case of recurrent cardiac tamponade or after heart surgery, it is important to evaluate the echocardiograms by considering the possibility of local pericardial adhesion. Even for patients believed to have a medium or small amount of effusion, it is essential to perform two-dimensional echocardiography and CT when there is any clinical suspicion of cardiac tamponade.

CT is an important aid in assessing the nature of the effusion fluid, as well as its volume and location. With increasing amounts of pericardial fluid it is possible to observe a circular fluid accumulation with a highly concentrated shadow around the heart on the periphery of the low-concentration area of the epicardial fat line. As the amount of fluid becomes larger, the thickness of this high-density shadow increases. The shadow tends to expand not only to the ventricular level but further to the cardiac base (2,13). This corresponds to the ice-bag shaped heart shadow seen on the chest X-ray films.

In the presence of a large amount of pericardial effusion, it is possible
to obtain the CT numbers and they may vary depending on the nature of the disease. Matsuyama et al. (13) reported that for patients with heart and renal failure, the CT numbers are 12-16, for acute pericarditis 18-22, for myxedema 27-30, for malignant pericarditis 19-40 and for constrictive pericarditis 180-250. Their results were roughly identical to ours. However, the CT numbers for the pericardial fluid must be viewed with some caution since they are susceptible to the influence of the surrounding epicardial fat tissue and the heart beat. In cases of recurrent pericardial effusion, it is of critical importance to ascertain the location of the effusion from the CT so as to assess the approach route to take for the pericardial fenestration procedure.

In the presence of a cardiac tamponade, the general practice is to perform pericardiocentesis from the left side of the xiphoid process first. It is even possible to drain as much as 500ml or more with a single puncture and the results obtained are sometimes excellent. However, in idiopathic pericarditis it is quite common for reaccumulation and again reaccumulation to occur after several months; in malignant pericardites, this may happen within a few days. Stable conditions may not be obtained until pericardial window surgery is performed. It is widely recognized for pleural effusion that continuous intrapleural tube drainage is better than repeated needle aspiraton. This philosophy can also be applied in exactly the same manner to pericardial effusion. However, pericardial drainage has so far been considered a more complicated procedure than pleural drainage, and therefore, it has not found wide application.
The first to suggest subxiphoid pericardiotomy for a cardiac tamponade was Larrey (1810), a French army physician under Napoleon (12). His name has survived in the designation of the Larrey point of pericardiocentesis. However, until recently, most surgery was performed by pericardial fenestration through left thoracotomy, and it was not until after 1967 (1, 3-5, 7, 8, 10-16) that reports were published on the results achieved with the subxiphoid pericardial window.

This method can also be applied in serious cases and the operation can be completed within 40 to 60 minutes under local anesthesia with a small skin incision. For dyspneic patients, this operation can even be performed in the semi-Fowler position. Our patients included one case of terminal cancerous cardiac tamponade who died during the operation. However, generally, this operation causes little invasion and is very effective even in urgent serious cases.

The cases of cardiac tamponade included in our studies were those of predominantly cancerous pericarditis. This is one of the terminal symptoms of malignant tumor patients, but with the pericardial window procedure, it was possible to overcome the crisis of the disease and allow many patients to be discharged from the hospital. In two cases, a second and a third operation become necessary. To prevent recurrence, full use of tetracycline instillation has been planned (4). Pericardial fenestration to the pleural cavity leads to a change from pericarditis carcinomatosa to pleuritis carcinomatosa. However, at present, it has been possible to achieve considerable extension of life in pleuritis carcinomatosa by means of anti-cancer drugs and immunotherapy. The present authors mainly use OK-432.

In the American and European literature (14-16) the classic cases of cardiac tamponade are predominantly uremic pericarditis, but in our series, uremia was seen in only one patient. At Tokai University Hospital and its affiliated clinics, a rather large number of patients suffering from chronic renal failure are on hemodialysis and their echocardiograms sometimes show pericardial effusion. However, the necessity of surgery for cardiac tamponade is quite rare if adequate medical treatment is provided.

REFERENCES


