Diagnosis of Traumatic Mediastinal Hematoma With Transesophageal Echocardiography*

Françoise Le Bret, M.D.; Patrick Ruel, M.D.; Hubert Rostier, M.D.; Jean-Pierre Goarin, M.D.; Bruno Riou, M.D.; and Pierre Viars, M.D.

In patients with blunt chest trauma, early diagnosis of mediastinal hematoma is important, because it could be associated with thoracic vessel injury. Mediastinal hematoma is generally evoked because of a widened mediastinum on chest radiograph, but radiologic diagnosis may lead to excessive angiography being performed. Transesophageal echocardiography (TEE) provides accurate views of the mediastinum and can be rapidly performed at the bedside. Thus, we conducted a prospective study to define TEE signs of mediastinal hematoma. TEE was performed in 22 thoracic trauma patients (trauma group) and in 20 brain-dead patients without thoracic trauma (control group). The positive diagnosis of mediastinal hematoma was made using thoracic surgery or computed tomographic scan. The specificity of TEE was 75 percent and sensitivity was 100 percent. In the trauma group, there was only one false positive but angiography discovered a traumatic aneurysm of the proximal right subclavian artery. No false negative was noted. We described three different TEE signs of mediastinal hematoma: (1) an increased distance between the probe and the aortic wall; (2) a double contour of the aortic wall; and (3) visualization of the ultrasound signal between the aortic wall and the visceral pleura. The distance between the esophageal probe and the aortic wall was the most accurate sign because it could be easily obtained; the threshold value for this distance was 3 mm. TEE appears to be an accurate method to diagnose traumatic mediastinal hematoma.

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ISS = injury severity score; TEE = transesophageal echocardiography \\
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In patients with blunt chest trauma, early diagnosis of mediastinal hematoma is important. Indeed, mediastinal hematoma could be related to various injuries: sternum, ribs, and vertebral fractures, and particularly rupture of thoracic main vessels. The diagnosis of mediastinal hematoma is usually evoked on a widened mediastinum on the chest radiograph.\textsuperscript{1,2} In critically ill patients, however, the mediastinal widening is extremely difficult to assess\textsuperscript{3} and, moreover, its normal width remains undetermined.\textsuperscript{4} Thus, the presence of widening mediastinum is not sufficiently specific to diagnose mediastinal hematoma and its absence is not sufficient to eliminate it. These factors may lead to performance of excessive investigations, such as angiography. Transesophageal echocardiography (TEE) is a simple and noninvasive diagnostic method that can be performed at the bedside in trauma patients. Recent studies have demonstrated that TEE could be very useful in the initial assessment of patients with thoracic trauma.\textsuperscript{5,6} Nevertheless, none of these studies has indicated that TEE could diagnose mediastinal hematoma. Thus, we conducted a prospective study in patients with thoracic trauma to assess the

*From the Department of Anesthesiology (Drs. Le Bret, Ruel, Goarin, Riou, and Viars) and the Division of Radiology (Dr. Grelet) (Dr. Rostier), Groupe Hospitalier Pitie-Salpêtrière, Paris, France. Manuscript received February 3, 1993; revision accepted May 21. Reprint requests: Dr. Riou, Anesthesiology, CHU Pitie-Salpetriere, 47 Blvd de l'Hopital, 75651 Paris Cedex 13, France.

METHODS

After ethical approval had been obtained, during a 26-month period (from February 1990 to April 1992), all trauma patients admitted to our Trauma Unit were prospectively included in the present study if they fulfilled the following inclusion criteria: (1) thoracic trauma; (2) TEE performed during the initial assessment of patients; and (3) availability of computerized tomodensitometry (CT) of the chest and/or thoracic surgery, enabling the confirmation of presence or absence of mediastinal hematoma. Because of the emergency conditions, informed consent was not obtained. However, this study did not modify the routine care of these patients in our unit.

Considering these inclusion criteria, a high incidence of mediastinal hematoma was expected in this trauma group. Consequently, we also studied a control group with patients known to have no mediastinal hemorrhage. We chose brain-dead patients admitted to our unit during the same period. These patients had no thoracic trauma and experienced no external cardiac resuscitation or thoracic surgery in the previous 6 months. In our unit, brain-dead patient hemodynamic status is systematically evaluated at the time of admission, using TEE. In all trauma group patients, the Injury Severity Score (ISS) was calculated as previously reported.\textsuperscript{7}

Transesophageal echocardiography

All TEEs were obtained in supine patients using a system (Hewlett-Packard) with a 5-MHz single plane probe. All patients were ventilated because of the severity of trauma in the trauma group, because of the neurologic status in the control group, and had normal cervical spine radiographs. During examination, patients with blunt chest trauma were maintained under sedation (continuous infusion with fentanyl and midazolam).

Transesophageal echocardiograms were recorded on a videotape for each patient. An experienced investigator, not informed of patients status, retrospectively analyzed TEE data in both groups. Figure 1 shows a normal view of the thoracic descending aorta. According to
tion of ultrasound signals between the aortic wall and visceral pleura (posterolateral aortic wall side) (Fig 4).

The acoustic nature of hematoma enables us to differentiate it from nonhemorrhagic effusion such as pleural effusion which provides no ultrasound signals.

The presence of only one of these three signs was required for the diagnosis of the mediastinal hematoma. These criteria for TEE diagnosis of mediastinal hematoma were chosen before the study was performed. Nevertheless, the threshold value for sign 1 was determined retrospectively after the study was completed. Since single-plane probe only provides views from the horizontal aorta, until the end of the descending aorta, the mediastinum was analyzed throughout these portions of the aorta.

**CT Scan**

A CT scan was obtained in 17 patients in the trauma group (the 5 remaining patients underwent emergent thoracotomy for aortic repair). The CT scans were analyzed by an independent radiologist. The CT scans had been made in different radiology units. Thus, ten patients received a rapid hand-injected contrast material. Scan was performed from the sternal notch to below the carina with a 10-mm thickness every 10 mm.

The hematoma CT criterion was a high density in the posterior mediastinal fat infiltrating the periaortic space.

Data are expressed as mean ± standard deviation (SD).

**Results**

During the study period, 22 patients fulfilled the inclusion criteria in the trauma group, which included 20 men and 2 women; the mean age was 33 ± 11 years (range, 18 to 55 years). In the same period, 20 brain-dead patients were included in the control group, 15 men and 5 women, mean age 30 ± 7 years (range, 20 to 41 years). No significant differences were noted between these groups. Trauma was related to falls (n = 8), motor cycle crashes (n = 7), and vehicle crashes (n = 7). The cause of brain death in the control group was cerebral hemorrhage (n = 14), head gunshot (n = 2), hanging (n = 3), and brain tumor (n = 1).

None of the 42 patients in this study presented any difficulties in having TEE performed; the results of TEE summarized in Table 1. In the trauma group, mediastin-
Table 1—Diagnostic Value of the Three TEE Signs 1 to 3 and TEE (Sign 1, 2, or 3)

<table>
<thead>
<tr>
<th></th>
<th>Trauma Group (n = 22)</th>
<th>Control Group (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MH Present (n = 19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign 1</td>
<td>Present 19, Absent 0</td>
<td>Present 0, Absent 2</td>
</tr>
<tr>
<td>Sign 2</td>
<td>Present 7, Absent 12</td>
<td>Present 2, Absent 20</td>
</tr>
<tr>
<td>Sign 3</td>
<td>Present 18, Absent 1</td>
<td>Present 2, Absent 20</td>
</tr>
<tr>
<td>TEE</td>
<td>Positive 19, Negative 0</td>
<td>Positive 0, Negative 2</td>
</tr>
<tr>
<td></td>
<td>Positive 19, Negative 0</td>
<td>Positive 0, Negative 2</td>
</tr>
</tbody>
</table>

MH = mediastinal hematoma (CT or surgery detected); TEE = transesophageal echocardiography.

Mediastinal hematoma was observed (during CT scan or surgery) in 19 (85 percent) patients. The mean ISS was 31 ± 10 (range, 13 to 66). The mean thoracic item ISS of these patients was 4.1 ± 0.8 (range, 2 to 5).

No false negative was observed with TEE (Table 1). Only one false positive appeared during this study; this patient had no mediastinal sign of hemorrhage on CT but the three TEE signs of mediastinal hematoma were observed. In the two trauma patients with no signs of mediastinal hematoma either on CT or TEE, one patient had a limited intimal tear of aortic isthmus on angiography. Aortography was performed because an aortic lesion was suspected during the arterial time of a pulmonary angiography indicated for possible pulmonary embolism. In patients with mediastinal hematoma, sign 1 was present in all of them, whereas sign 2 was present in only 7, and sign 3 in only 17 patients.

Measurement of the distance between the transducer and the aortic wall in the 42 patients suggested a threshold value of 3 mm for this distance (sign 1): indeed, all patients with mediastinal hematoma presented a value greater than 4 mm, whereas in the control group and in one patient of the trauma group without mediastinal hematoma, it was inferior or equal to 3 mm, except for the patient with the false positive (5 mm) (Fig 5).

Discussion

Until now, in patients with blunt chest trauma, chest radiograph is usually the first examination to be rapidly obtained at the bedside. There are many obvious difficulties in interpreting chest radiographs in trauma patients. Widened mediastinum is not sufficiently specific of mediastinal hematoma in the supine position. Ayella et al8 suggested that obtaining the true erect view could eliminate unnecessary aortography in those patients. This erect chest radiograph might be contraindicated in trauma patients with unstable hemodynamic status. Moreover, investigations such as angiography may be extremely difficult in these trauma patients. However, confirmation of mediastinal hematoma requires further investigations because the incidence of aortic rupture is 12.5 percent in patients with clinical and/or radiographic evidence of mediastinal hemorrhage.9

Transesophageal echocardiography is a procedure that can be performed rapidly at the bedside without administration of contrast medium and that can be repeated during the first hours. In our emergency unit, TEE is routinely performed in patients who have sustained chest trauma. In our experience, TEE provides accurate views of the mediastinum, and no complication can be observed. Therefore, we conducted a study to define TEE signs of mediastinal hematoma. The presence of a mediastinal hematoma was confirmed either directly during thoracic surgery or with CT, which is usually considered to be the "gold standard" method for examination of the mediastinum.10-12 The high incidence of mediastinal hematoma in our trauma group may be explained because the CT was performed only in the patient with most severe chest injury. Indeed, in our institution, CT is not easily available for all patients with thoracic trauma. Thus, our selection criteria introduced an element of bias in the incidence of mediastinal hematoma (86 percent in the present study vs 18 to 25 percent in the literature).8,11 Another explanation for this high incidence of mediastinal hematoma was the severity of thoracic trauma in the trauma group: mean thoracic item ISS was 4.1 for a maximal value of 5.
We found a specificity of 75 percent for the TEE, but its sensitivity was 100 percent. These results should be carefully interpreted because of the small sample. There was only one false positive, but angiography in this patient showed a traumatic aneurysm of the right subclavian artery. We may explain the positivity of TEE in this case by the greater ability of ultrasound to detect a small mediastinal collection: Miller et al. described five patients with arterial injury in whom CT failed to show a mediastinal hemorrhage. It should be pointed out that one of these five patients had an injury involving the subclavian artery, just as in our patient. In the future, the new CT technology with a 2-mm thickness may improve the sensitivity of hematoma detection.

Sign 1 appears to be the best TEE sign of mediastinal hematoma because it was observed in all patients with mediastinal hematoma. We defined a threshold value for the distance between the aortic wall and the probe of 3 mm. Nevertheless, it should be emphasized that in patients without mediastinal hematoma, this distance is associated with a virtual space and that the measurement is related only to the technical limitation of the echography and videotapes. Thus, we considered that a value less than 1 mm was the inferior limit that could be accurately measured using TEE. The main advantage of sign 1 is that it is easily obtained even by an untrained echocardiographer. Sign 1 should be measured at the level of the descending thoracic aorta since the distance between the probe and the aortic arch increases. In contrast, signs 2 and 3 probably require a greater experience of detection when performing TEE. Nevertheless, it should be pointed out that sign 2 (double contour of the aortic wall) may indicate either a mediastinal hematoma or an intramural hematoma involving the aortic wall itself. Consequently, its association with sign 1 is important to definitively diagnose mediastinal hematoma and the consequences (ie, aortic angiography) are the same.

This study was conducted using a single-plane probe. Since omni plane probes are now available, it should be pointed out that the accuracy of TEE in the diagnosis of mediastinal hematoma could be improved by the use of such probes.

In the trauma group, one patient had a limited traumatic aortic lesion (with only a small aortic wall hematoma) but no collection in the mediastinum, detected by CT and surgery. Such cases have been described previously in the literature. This explains why the TEE was normal and thus this patient was not a false negative of TEE.

In conclusion, TEE is a reliable examination to diagnose mediastinal hematoma in blunt chest trauma. This mediastinal collection is diagnosed if TEE shows one of the three signs: (1) the widening of space between the esophageal probe and aortic wall; (2) double contour of the aortic wall; and (3) ultrasound signals in the space between aortic wall and visceral pleura. However, the presence of sign 1 is sufficient to diagnose mediastinal hematoma and its threshold value is 3 mm (ie, distance greater than 3 mm indicates the presence of mediastinal hematoma). In patients with mediastinal hematoma, further investigations are required to diagnose the accurate sign of mediastinal hematoma, including aortography. Indeed, the value of TEE for the diagnosis of mediastinal hematoma origin remains presently questionable, even if preliminary studies suggest that TEE could precisely diagnose traumatic aortic injury.

REFERENCES

11. Richardson P, Mirvis SE, Soorpio R, Dunham CM. Value of CT in determining the need for angiography when findings of mediastinal hemorrhage on chest radiographs are equivocal. AJR 1991; 156:273-79