

Radiologic Evaluation of Blunt Traumatic Rupture of the Diaphragm

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Incidences of traumatic rupture of the diaphragm are increasing with the rise in traffic accidents. Diagnosis of acute presentation of the diaphragm is simple, but delayed presentation is often missed since there is neither acquisition of a history of trauma, nor usage of proper diagnostic modalities.

We analyzed retrospectively our experiences of the last 3 years of blunt diaphragmatic rupture, which were surgically proven at Gil Hospital. The results were as follows:

1. Incidence of acute presentation of diaphragmatic rupture (n=9) was more frequent than that of delayed presentation.
2. Incidence of diaphragmatic rupture (n=12) was more frequent than that on the right.
3. The herniated organs were the stomach, greater omentum, spleen, and liver in frequency.
4. Common chest X-ray manifestations of the diaphragmatic rupture were unilateral elevation of the diaphragmatic shadow, pleural effusion, shifting of the mediastinum, atelectasis (or lung contusion), and rib fracture.
5. CT scanning of the right-sided diaphragmatic rupture showed typical findings of herniated liver.

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Introduction

Traumatic rupture of the diaphragm (TRD) is seen with high frequency, most commonly as a result of traffic accidents. When it is early detected early, it can be easily corrected, but if the diagnosis is missed, an internal hernia develops almost inevitably with all its potentially serious, and sometimes fatal complications (1,3,5). Lack of suspicion has been a major factor in cases of missed and delayed diagnosis of TRD. In less than 50% correct diagnosis is done (1,6,7).

Injuries of the diaphragm are of two types. One is a direct type which is stab or bullet wound and the other is an indirect type which is blunt injuries due to traffic accidents or falls from heights (3,8). This review covers our experiences of the indirect types, and reports on the characteristic findings of the right sided TRD with partial herniation of the liver on CT.

Materials and Methods

We reviewed 14 cases of blunt TRD which were surgically proven at Chung Ang Gil General Hospital from June, 1987 to May, 1990. The patients were 27-68 years old (mean, about 44 years).

Of all accidents 11 cases were due to traffic accidents (pedestrian injury 7, motorcycle injury 2, in-car injury 2). Other injuries included work and home accidents and unknown causes respectively.

Plan chest X-rays were evaluated to assess the following findings; 1) elevation of the diaphragm shadow, 2) atelectasis or lung contusion 3) abnormal gas pattern 4) rib fracture 5) pleural effusion and 6) contralateral shifting of mediastinal structures (3,6,7). Among the above findings, we defined the abnormal increased density on the ipsilateral lung field as atelectasis or lung contusion. Elevated diaphragmatic

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shadows that were located above the ipsilateral pulmonary hilum were grouped separately as "severe".

We defined TRD that was detected two weeks after trauma as delayed presentation of TRD. Diagnosis of delayed TRD was evaluated by barium upper gastrointestinal series, sonography, and CT (sonography: SSD-650, Aloka, CT: Somatom DRH, Siemens). Two patients with herniated stomachs were diagnosed with barium upper gastrointestinal study. Two patients with herniation of solid organs were diagnosed with sonography only and another patient with partial herniation of the liver was diagnosed with both sonography and CT.

Results

In our group of patients, TRD was more frequent on the left side (n = 12) than right sided tears (n = 2).

Associated injuries are listed on Table 1. The most common organ injury was the spleen and the most common bone fracture was the rib. The most common herniated organs were the stomach and greater omentum which were observed in 8 patients (n = 14). Other herniated organs were the spleen, liver, colon and small bowel.

Radiologic findings of plain chest X-ray revealed

Table 1. Associated Injuries (n = 14)

Organ Injury		Bone fracture	
Spleen	6	Rib	9
Liver	3	Long Bone	8
Lung	3	Pelvis	6
Brain*	2	Spine	3

*Intracranial hemorrhage detected on the CT

Table 2. Manifestations of Plain Chest X-ray (n = 14)

Elevation of the diaphragmatic shadow	12
Mild type	4
Severe type	8
Pleural effusion	9
Shifting of the mediastinum	9
Rib fracture	9
Atelectasis or Lung contusion	8
Abnormal gas bubbles	7
Pneumothorax	2

unilateral elevation of the diaphragmatic shadow in 12 cases, shifting of the mediastinum in 9 cases pleural effusion in 9 cases, rib fracture in 9 cases atelectasis or lung contusion in 8 cases, and abnormal gas bubble in 7 cases (Table 2). The severe type with elevated diaphragmatic shadow was more frequent (n=8) than the mild type (n=4).

Delayed TRD was less frequent (n=5) than the acute presentation (n=9).

Manifestation of barium gastrointestinal study showed typical findings of waist-like constriction with or without obstruction (Fig. 1). One case showed obstruction of the efferent loop while another didn't show passage disturbance. Three cases were diagnosed with sonography. Two cases showed partial herniation of the liver and another showed elevation of the spleen (Fig. 2).

One case of right sided TRD, confirmed by CT, showed typical findings that suggested partial herniation of the liver. The two findings were lateral displacement of the liver dome and the other was "pinching-off" contour of the medial aspect of the liver dome at the tearing level (Fig. 3)

Discussion

Carter et al. classified TRD as immediate, interval, and obstructive phase. In the immediate phase, the hernia may be recognized during the period of hospitalization immediately following the trauma. But if the TRD is not recognized during the immediate post-traumatic period, the patients may recover and remain symptom free, or suffer from chronic abdominal and/or chest symptoms, or present with an acute crisis, often with signs of intestinal obstruction or strangulation. These were described as interval phase and obstructive phase respectively (2,3). Recently these two phases were grouped as delayed presentation (2,6). Early diagnosis of TRD was less than 50% in previous reports (1,6,7). Of our cases, incidence of acute presentation was more common.

Right sided tears are known to be less common, occurring in about 8-30% of traumatic hernias (3,4,6). The diaphragm on the right side is less vulnerable

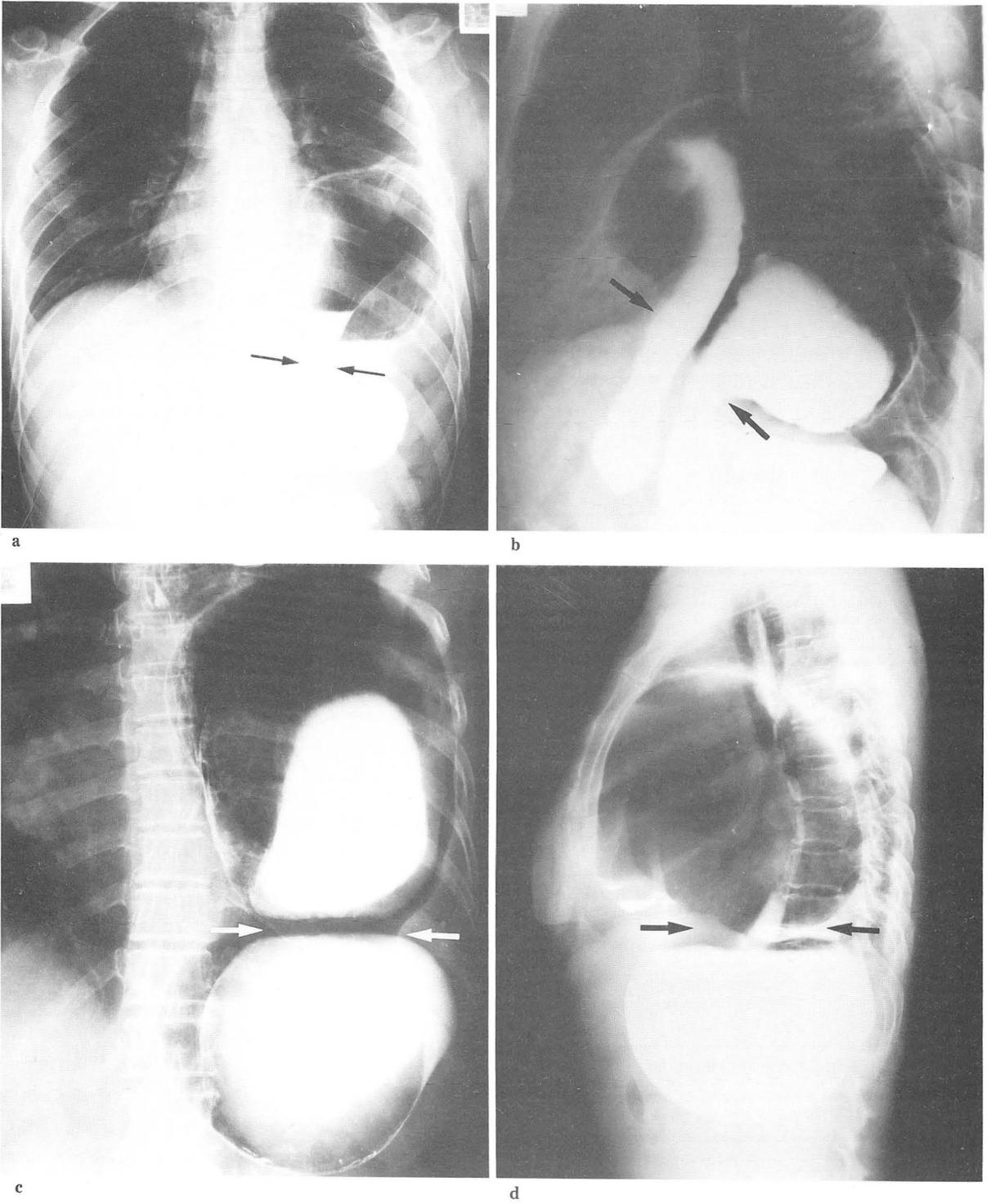


Fig. 1. Barium gastrointestinal study. "Waist-like" constriction at the diaphragmatic rent is well visualized (arrows). Note that the two limbs of the loop of the stomach lie side by side and each is indented where it passes through the diaphragm:

a. and b. show filling of all segments and no obstruction to flow of barium c. and d. show filling of esophagus and herniated stomach and obstruction of the efferent loop

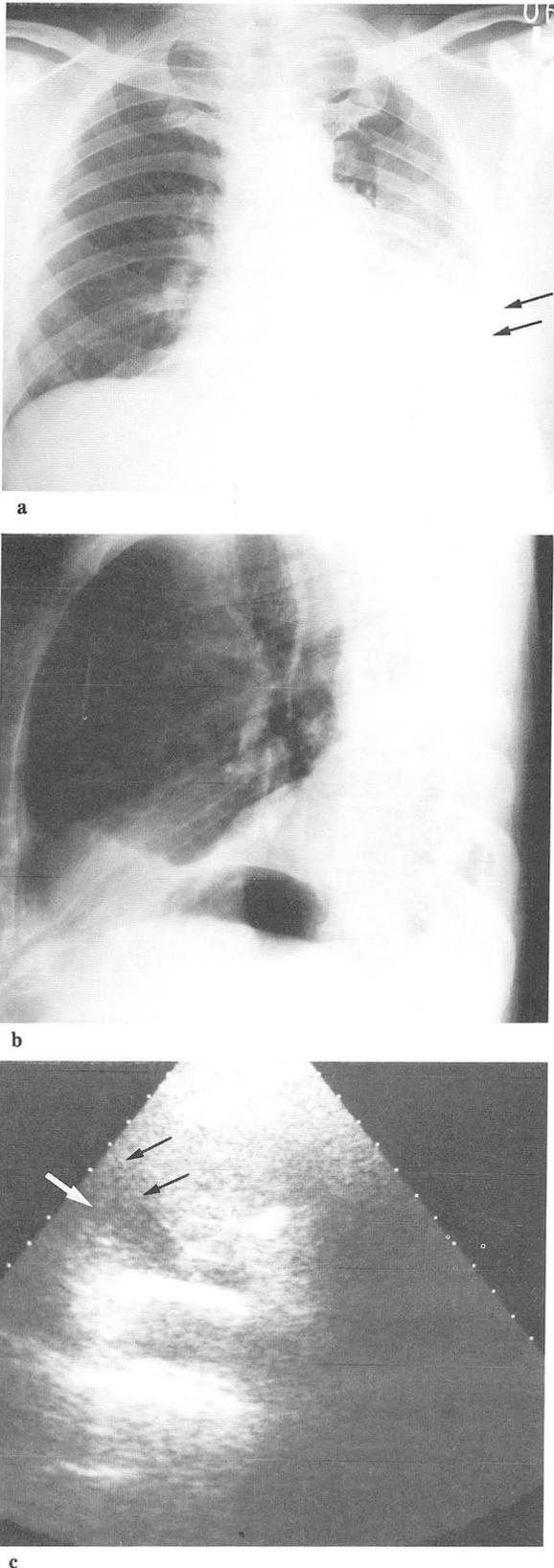


Fig. 2. Left-sided diaphragmatic rupture. This delayed presentation shows: a. and b. Mild elevation of left diaphragmatic shadow and lower rib fracture (arrows) on chest PA and lateral view. c. Highly located spleen (black arrows) and pleural effusion (white arrow) on sonography. Surgery revealed herniation of the ruptured spleen and hemofibrothorax.

than on the left side because of the protective function of the liver and kidney (6,8).

In previous reports (9,10) associated injuries included rib fractures, rupture of the liver or spleen, aortic injury and CNS injury. Our results consistent with their findings.

Normally positive intrapleural pressure allows intrathoracic herniation of almost all abdominal viscera but most often the stomach, greater omentum, and spleen (6,10). Our findings again coincide with this.

Radiologic findings of TRD on plain chest X-ray were originally described by Carter et al. as: 1) arch-like shadow resembling an abnormally high diaphragm, 2) extraneous shadows such as gas bubbles, 3) shift of the heart and mediastinum, and 4) disc or plate-like atelectasis (3). We added ipsilateral pleural effusion and rib fracture to those findings for favorable findings of TRD.

Barium study may demonstrate a herniated stomach, large bowel or small bowel. If the bowel is incarcerated through the single defect in the diaphragm, the afferent and efferent limbs lie side by side. Obstruction may occur in afferent or efferent limb and a funnel or beak shape be found. In our cases one cases show no evidence of passage disturbance and the other cases which show obstruction of the efferent limb (1,3,6).

Sonographic diagnosis of TRD was case-reported in delayed presentation of left sided tears (11). However, left ruptures may be difficult to diagnose sonographically because of the confusing images caused by the air containing stomach, small bowel, or colon. Right ruptures are easier to diagnose with sonography because the normal diaphragm can be demonstrated adjacent to the liver and at the site of rupture, the liver can be seen to herniate above the diaphragm (6). Our cases (n=3) were not confirmed with sonography, but only suggested elevated liver in right sided tears and high positioned spleen in left

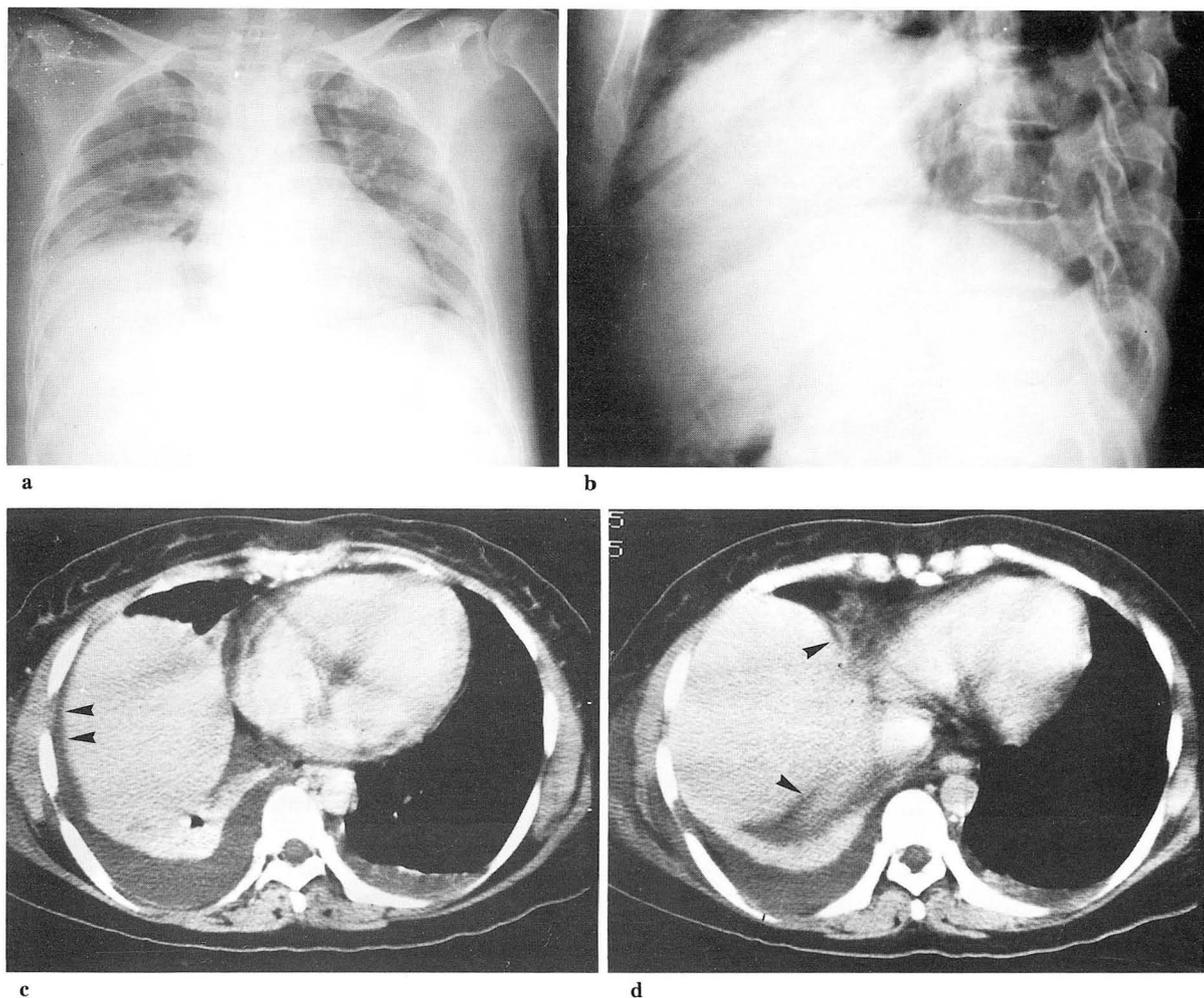


Fig. 3. Right-sided diaphragmatic rupture.

a. and b. Mild elevation of right diaphragmatic shadow and pleural effusion are noted.

c. Lateral tilting of liver dome (arrow heads), bilateral pleural effusion and collapsed lung are noted on CT.

d. "Pinching-off" contour of liver density is noted at the diaphragmatic rent (arrow heads).

sided tear.

A left-sided case of TRD demonstrated by CT was case-reported (12,13). We reported right sided tears on CT first, which showed partial herniation of the liver. Typical findings were described by; 1) lateral tilting of the liver dome. 2) so called "pinching-off sign" which separates liver parenchyme at the tearing level. In complete herniation of the liver due to a large defect of the diaphragm, we recommend other diagnostic modalities such as diagnostic pneumoperitoneum or MRI (4,14).

Despite all of these tests, it is often difficult to diagnose a TRD. Therefore, the radiologist's role is to carry a high index of suspicion, and suggest the

possibility of TRD when indicated to the surgeon, who is often treating the patients other life threatening problems.

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〈국문 요약〉

간접 외상성 횡격막 파열의 방사선학적 고찰

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외상성 횡격막 파열의 빈도는 교통사고의 증가로 점차 증가하고 있다. 급성 횡격막파열인 경우는 대개 단순 흉부 촬영으로 끝나지만 지연성 파열인 경우는 기타 적당한 진단 방법을 필요로 하게 된다.

저자들은 최근 3년간 중앙 길 병원에서 수술로 확진된 14례의 외상성 횡격막 파열을 대상으로 각종 방사선 검사를 분석하여 다음과 같은 결과를 얻었다.

1. 급성 횡격막 파열의 빈도(n=9)가 지연성 파열보다 높았다.
2. 좌측파열의 빈도(n=2)가 우측보다 높았다.
3. 빈도가 높은 탈출 장기는 위, 대만, 비장 및 간 등의 순이었다.
4. 주로 보이는 단순 흉부 촬영 소견은 일측성 횡격막 음영의 상승, 늑막 삼출, 종격동의 이동, 무기폐(또는 폐좌상) 및 늑골 골절 등이었다.
5. 우측 횡격막 파열시 CT 스캔상 간탈장을 시사하는 특징적인 소견을 보였다.

결론적으로 지연성 파열의 경우 일차적으로 의심하는 것이 중요하고 위장관 탈장이 아닌 경우에 초음파나 CT를 적절히 적용하는 것이 요망된다.