Original article

Chest radiography diagnosis of pulmonary contusion is associated with increased morbidity and mortality

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Abstract

Background: **The aim of this study is to compare morbidity and mortality rates of patients with Chest Radiography (CXR) proven pulmonary contusion and normal CXR but pulmonary contusion on contrast Computed Tomography (CT).**

Methods: **Cases were divided into two groups according to diagnosing method: CXR-proven (CXR-group) and CT-only diagnosed pulmonary contusion group (CT-group). Groups were compared for Injury Severity Score (ISS), Length Of Stay in Hospital (LOSH), length of stay in Intensive Care Unit (ICU), Arterial Blood Gas (ABG) changes, andmorbidity and mortality rates.**

Results: **Mean LOSH and LOSI were significantly longer (23.09 ±4.01 and 13.42 ±3.47) in CXR group than in the CT group (10.97±3.27 and 3.59±1.54). Mean ISS score was significantly higher in the CXR group (38.63±19.37) than in the CT group (22.74±18.00). Mean ABG results were significantly poorer in the CXR group than in the CT group. The percentage of the cases requiring mechanic ventilation was 54.5% in the CXR group. Morbidity and mortality rates were 45.4% and 27.7% in the CXR group and 10.8% and 4.3% in the CT group, respectively.**

Conclusion: **Diagnosis of pulmonary contusion by CXR is associated with higher morbidity and mortality rates.** ***(Ind J Thorac Cardiovasc Surg 2010; 26: 24-29)***

Key words: Pulmonary, Chest, Computed tomography

Introduction

Pulmonary contusion is the most frequent injury seen with blunt thoracic trauma andmanagement in emergency rooms has significant influence on morbidity and mortality[1,2]. An accurate diagnosis and appropriate surgery methods are main factors to decrease morbidity and mortality in these patients[3].

The CXR has been the traditional means for the detection of pulmonary contusion, but is limited by the occasional delay in appearance of the characteristic opacities. Computed tomography scan is a sensitive means for detecting the pulmonary injury. Not only does thoracic CT detect changes earlier in the course of injury, but it also provides a more comprehensive estimate of the extent of involvement. CXR may underestimate pulmonary contusion size in 60% of cases when compared with concomitant thoracic CT[4,5].

Clinical examination and imaging studies after stabilization of trauma patients are fundamental subjects in deciding the approach and treatment[6]. Chest radiograph is the first imaging method in patients assumed with thorax injury. Further examinations may follow according to injury type and haemodynamic stability. Thorax computed tomography is reported to be useful in assessing injuries in lung parenchyma, airways, chest wall and diaphragm[6,7]. In addition, CT is found to be superior to CXR in detecting pulmonary contusion, pneumothorax and haemothorax due to a higher sensitivity[8,9].

This study examines the treatment methods, clinical course, Injury Severity Scores (ISS), and Arterial Blood Gases (ABGs) and morbidity and mortality rates of patients with CT-only diagnosis of pulmonary contusion

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Received - 18/08/09; Review Completed - 12/01/10; Accepted - 13/01/10.

and compares them with that of patients with CXR-proven pulmonary contusion.

Materials and Methods

From the period of 1 April 2004 to 1 April 2008, records of patients admitted to our clinic with the diagnosis of blunt thorax trauma were reviewed and pulmonary contusion patients were included into the study. Institutional ethics committee approval was obtained for the retrospective review of patient records.

All available data about demographic information such as age and sex, mechanism of injury,Injury Severity Score (ISS), blood gas analysis results, the types of imaging studies (CXR,chest CT) obtained, duration of stay in the Intensive Care Unit (ICU) and the duration of hospital stay were collected. Mortality data were also collected.

Chest CT scans were performed using a Siemens Somatom Sensation (16 slice) scanner. The chest was scanned from the lung apices to the diaphragm in 5-mm intervals. Before CT scan,all patients were given 2 mL/kg Omnipaque 300 (*Amersham Health, Ireland*) intravenously. Patients were divided into two groups based on the radiology method used; group I consisted of patients with pulmonary contusion diagnosed only with CXR (CXR group) and group II diagnosed with CT (CT group).

Records revealed that arterial blood gas specimens were obtained from the femoral artery inall patients using a heparinized syringe with a small needle. The samples were corked off immediately to prevent exposure to room air and transported to the laboratory in 2-4 minutes.Tests were performed at days 1, 2, 3 and 7 with the same device (Radiometer ABL 700,ABD).

Statistical analysis ($p < .05$ considered significant) was performed using the STATISTICA software program. Continuous variables are expressed as mean ± SD, where appropriate. Comparison of means of age, duration of stay in the ICU, length of hospital stay, and ISS scores were performed with Student t test. Two-way repeated measurement Analysis of Variance (ANOVA) was used for comparison of blood gas results at different days. All comparisons among means were carried out with Duncan's multiple range test.

Results

During the study period, a total of 298 blunt trauma cases were admitted to our clinic. Of these, 57 patients were considered for pulmonary contusion and confirmation was made based on CXR findings at first assessment in 11 (19.30%) patients (Figs. 1 & 2) whereas in 46(80.70%) patients based on CT scans (Figs. 3 & 4). Basic characteristics of the patients are displayed in (Table 1).

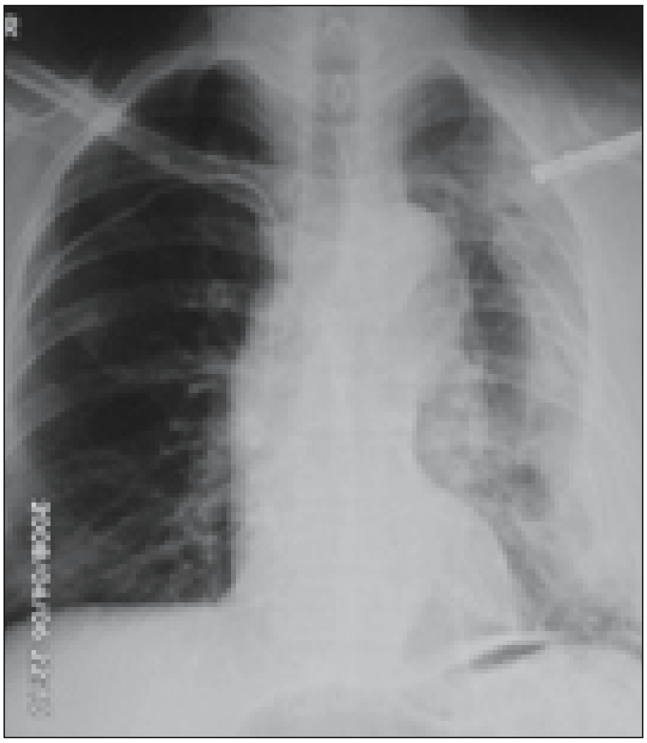

Fig. 1. Left pulmonary Contusion on chest radiograph.

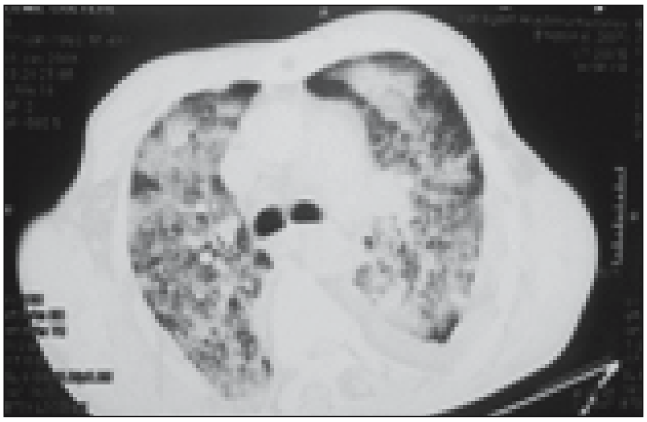

Fig. 2. Bilateral contusion of the same patient seen on CT.

Both groups had a similar mean of age (Table 1). Patients in the CXR group had significantly higher ISS scores than the CT group ($p<0.01$). Length of hospital stay (LOSH) and LOSI was significantly higher in the CXR group than in the CT group also ($p<0.01$). Overall, motor vehicle crashes accounted for 54.38% of all cases.

IJTCVS
2010; 26: 24–29

Table 1. Characteristics of patients, diagnosis of pulmonary contusion and clinical course

	GROUP I n = 11 (19.30%)					GROUP II n = 46 (80.70%)				
	Mean	**SEM**	**SD**	**Min.**	**Max.**	**Mean**	**SEM**	**SD**	**Min.**	**Max.**
Age	49.64 A	8.53	28.28	11	76	49.20 A	1.90	12.88	19	74
LOSH	23.09 A	1.21	4.01	17	30	10.98 B	0.48	3.27	6	20
LOSI	14.09 A	1.05	3.48	7	21	3.59 B	0.23	1.54	0	6
ISS	38.64 A	5.84	19.38	14	71	19.63 B	2.16	14.65	5	71

CXR= chest radiograph, CT= computed tomography, LOSH= length of stay in hospital, LOSI= length of stay in intensive care unit, ISS= injury severity score, SEM= standard error of mean, SD= standard deviation, Min.= Minimum, Max.= Maximum,
Different upper case letters in same rows resemble significant difference between means (p<0.01)

Fig. 3. Contusion of left and right lower lobe seen on CT.

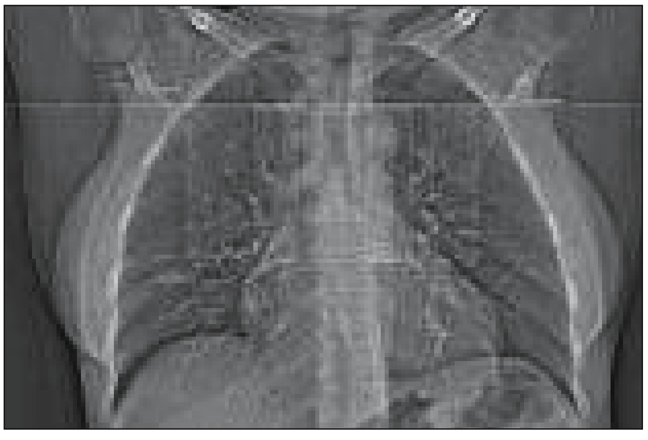

Fig. 4. This patient's x-ray was normal.

The most common associated injury of the thoracic wall in our cases was rib fracture (42.10%). The most common determined intra-thoracic injury was pneumothorax in the CXR-only group with 63.63%. In the CT group, haemo-pneumothorax was the most common associated injury with19.56% (Table 2). Contusion was usually localized in patients with rib fracture. Diffuse contusion was associated with less rib fractures (2 or less) or no fractures in general. In total,the most common associated extra-thoracic finding was trauma to the extremities (21.05%).Trauma to the head was the most common associated extra-thoracic trauma in the CXR-only group. Injury types and rates are shown in (Table 2).

Arterial blood gas analysis at days 1, 3 and 7 demonstrated significant differences in partial oxygen pressure (PaO2), Partial Carbon Dioxide Pressure (PaCO2), Bicarbonate (HCO3), and Base Excess (BE) levels between two groups (p<0.01) (Table 3).

Patients were treated with conservative methods in 70.08%. The percentage of patients in the CXR group requiring mechanical ventilation was 54.54%. Morbidity and mortality rates were 45.45% and 27.27% in Group I and 10.86% and 4.34% in Group II, respectively (Table 4).

Table 2. Distribution and rates of associated injuries in pulmonary contusion cases

Associated injuries	Group I (%)	Group II (%)	Total (%)
Thoracic wall			
Rib fracture	11 (100.00)	13 (28.26)	24 (42.10)
Multiple rib fracture	6 (54.54)	3 (6.52)	9 (15.78)
Multiple rib fracture + flail chest	5 (45.46)	-	5 (8.77)
Sternum fracture	3 (27.27)	2 (4.34)	5 (8.77)
Scapula fracture	1 (9.09)	1 (2.17)	2 (3.50)
Clavicle fracture	3 (27.27)	1 (2.17)	4 (7.01)
Subcutaneous emphysema	4 (36.36)	3 (6.52)	7 (12.28)
Intra-thoracic			
Pneumothorax	7 (63.6)	5 (10.86)	12 (21.05)
Haemothorax	2 (18.18)	6 (13.04)	8 (14.03)
Haemo-pneumothorax	2 (18.18)	9 (19.56)	11 (19.29)
Myocardial contusion	1 (9.09)	-	1 (1.75)
Diaphragm rupture	1 (9.09)	1 (2.17)	2 (3.50)
Extra-thoracic			
Head trauma	7 (63.63)	2 (4.34)	9 (15.78)
Vertebral trauma	3 (27.27)	2 (4.34)	5 (8.77)
Extremity trauma	6 (54.54)	6 (13.04)	12 (21.05)
Abdominal trauma	1 (9.09)	5 (10.86)	6 (10.52)
Peripheral vessel trauma	-	4 (8.69)	4 (7.01)

Table 3. Arterial blood gas analysis results of two groups

	GROUP I n = 11 (19.30%)					GROUP II n = 46 (80.70%)				
	Mean	**SEM**	**SD**	**Min.**	**Max.**	**Mean**	**SEM**	**SD**	**Min.**	**Max.**
PaO2 day 1	68.18 c B	2.17	7.21	57	78	76.80 c A	0.38	2.59	73	81
PaO2 day 3	70.27 b B	1.85	6.15	61	78	80.24 b A	0.56	3.79	76	89
PaO2 day 7	74.09 a B	1.58	5.24	67	81	84.41 a A	0.21	1.44	81	88
PaCO2 day 1	51.82 a A	1.16	3.84	46	57	47.00 a B	0.21	1.41	44	49
PaCO2 day 3	48.91 b A	1.18	3.91	43	54	40.37 b B	0.26	1.77	36	43
PaCO2 day 7	45.09 c A	1.27	4.21	40	51	36.20 c B	0.15	1.05	35	39
HCO3 day 1	15.64 c B	0.65	2.16	13	19	23.24 c A	0.17	1.18	21	25
HCO3 day 3	19.73 b B	0.38	1.27	18	22	23.96 b A	0.11	0.73	23	25
HCO3 day 7	21.73 a B	0.47	1.56	20	24	25.04 a A	0.12	0.82	24	27
BE day 1	1.68 b B	0.05	0.18	1.4	1.9	2.22 c A	0.02	0.14	2.0	2.4
BE day 3	1.79 a B	0.03	0.09	1.6	1.9	2.38 b A	0.02	0.12	2.0	2.5
BE day 7	-	-	-	-	-	2.44 a	0.01	0.08	2.3	2.5

PaO2= partial oxygen pressure, PaCO2= partial carbon dioxide pressure, HCO3= bicarbonate, BE= base excess, SEM= standard error of mean, SD= standard deviation, Min.= Minimum, Max.= Maximum,
Different upper case letters in same rows resemble significant difference between means (p<0.01)
Different lower case letters in same columns resemble significant difference between time means (p<0.01)

Table 4. Treatment methods, morbidity and mortality rates in both groups

	Group I n (%)	Group II n (%)	Total n (%)
Treatment			
Conservative	5 (45.46)	35 (76.08)	40 (70.18)
Mechanical ventilation	6 (54.54)	11 (23.91)	17 (29.82)
Morbidity	5 (45.46) ARDS (n=1) Pneumonia (n=2) Wound infection (n=1) Empyema (n=1	5 (10.86) Pneumonia (n=2) Empyema (n=1) Wound infection (n=2)	10 (17.54)
Mortality	3 (27.27) ARDS+ Sepsis (n=1) Intracranial hemorrhage (n=2)	2 (4.34) Intracranial hemorrhage (n=1) Intra-abdominal hemorrhage (n=1)	5 (8.77)

ARDS= Adult respiratory distress syndrome

Discussion

Trauma to the thorax is one of the main causes of death in adults aged 20 to 40 years.Affecting the lungs and the heart causes detoriation of the ventilation and results in injury inother systems while influencing mortality[10]. Pulmonary contusion is the injury of the parenchyma characterized with hemorrhage and edema in the alveoli causing failure of the respiratory functions[2,11,14]. This condition develops 24 hours after blunt trauma to the lungs and decreases perfusion/ ventilation gradient causing an increase in the pulmonary vascular resistance and decreasing pulmonary compliance. Significant inflammatory reactionin severe pulmonary contusion patients may develop bilateral Adult Respiratory Distress Syndrome (ARDS) in 50 to 60%[12]. Pulmonary contusion develops in 17 to 20% of severe chest trauma cases[11]. We have determined 57 (19.13%) cases of pulmonary contusion out of 298 blunt chest trauma cases in four years in this study. Motor vehicle accidents are the main cause of chest traumas and consequently of pulmonary contusions. It is observed in 25to 35% of blunt traumas and is usually the result of high-speed deceleration of the moving chest colliding against a stable object. It has been observed after falling, exercise injuries and physical violence[12]. Motor vehicle accidents were the main cause of trauma with 77.19% in our study.

Blunt trauma to the thorax is more common in males than in females[1,2]. This was also the case in our study in accordance with the literature.

The chest wall bones in children are more flexible than in adults with the result of higher transmission rates of the crushing effect to the lung tissue. Therefore, contusion is observed more common in children. Nevertheless, death rates associated with pulmonary contusion are similar in children and adults (14-40%)[11]. The rate of children in our blunt thorax trauma cases was 10.73% and pulmonary contusion developed in 7.01%. Pulmonary contusion was confirmed with CXR in all our children patients.

Blunt trauma to the thorax causes multiple organ injuries in 70 to 90% with associated head, neck, extremity and abdominal injuries[15]. Pulmonary contusion after a severe trauma to the chest can be associated with chest wall injuries and intra-thoracic injuries. Pulmonary contusion together with a fracture can usually be located but absence of a fracture indicates diffuse damage. Flail chest is typically observed together with pulmonary contusion[16]. We detected flail chest in 8.77% among our cases with pulmonary contusion (Table 2).Pneumothorax and haemothorax are found frequently together with contusion[13,17]. In this study, intra-thoracic injuries were pneumothorax (21.05%), hemopneumothorax (19.29%) and haemothorax (14.03%) (Table 2).

It is important to identify the type of injury for the diagnosis of pulmonary contusion. A thorough physical examination is essential together with radiographic imaging methods[18]. Chest radiograph is the first evaluation method to choose in thorax trauma but its sensitivity is low in the early period of the injury[17]. Anterior-posterior chest radiography is usually performed in supine position in traumatic patients in the emergency room. Although sensitivity in detecting pulmonary injuries is high, specificity is very low. In 1/3 of patients with pulmonary contusion the first chest radiograph cannot detect the injury[19]. Cases inwhom the first radiograph identifies pulmonary contusion are likely to have confronted withmore severe trauma. Contusions that are not detectable on the chest radiograph are easily diagnosed with CT[15]. It has been reported that CT is superior in 30 to 60% in determining pulmonary injury in patients with thorax trauma[8]. Pulmonary contusion was confirmed based on CXR findings at first assessment in 19.30% of the patients whereas in 80.70% of the patients based on CT scans in this study.

Analysis revealed that length of stay in hospital and intensive care unit was significantly longer in the CXR group than in the CT group ($p<0.01$)

It is reported that ISS in patients with contusion caused by blunt trauma to the thorax is greater than 15. (11,14) In our study, the ISS was above 15 in both groups with the mean ISS higher in the CXR group than in the CT group. This could be explained by the head trauma rates being significantly higher in the CXR group.

Arterial blood gas analysis is important in patients with contusion to prevent low oxygenlevels[17]. Nevertheless, blood gas levels have not to change in the early period[20]. In our study, PaO2, PCO2, HCO3, and BE levels were significantly poorer in the CXR group compared with the CT group in all days of analysis.

Effective treatment of pulmonary contusion includes supportive treatment with monitoring respiratory functions, oxygen saturation and hydration. Complications can occur mainly in the form of pneumonia and ARDS. The goal of treatment is to prevent respiratory failure andhypoxia[14,21]. Oxygen therapy with heated and humidified air is applied to the patient[22]. The need for ventilatory support can arise in some patients with respiratory failure[19]. In our study, the percentage of patients requiring mechanical ventilation was significantly higher if pulmonary contusion was determined on chest radiographs (Group I) indicating more severe respiratory failure.

Mortality rates associated with pulmonary contusions are related to the extent and severity of the injury[23]. Mortality rate was 8.77% in our study with intracranial hemorrhage being the major (60.00%) cause. In fact, mortality rate was significantly higher in the CXR group thanin the CT group.

In conclusion, confirmation of the diagnosis of pulmonary contusion was by chest radiograph appears to have a worse clinical course or outcome in patients compared with those in whom the diagnosis was confirmed by CT. The percentage of patients admitted to the ICU, requiring mechanical ventilation, mean ISS, and the length of hospitalization were all significantly higher if pulmonary contusion was evident on chest radiographs. Although treatment needs to be individualized according to clinical presentation, the finding of pulmonary contusion by CXR alone seems to increase patient morbidity and mortality.

Acknowledgements

We wish to thank Dr. Tamer Edirne for his contribution in translating this work into English.

References

1. Er M, I ik AF, Kurnaz M, Çobanoglu U, Sagay S, Yalçýnkaya I. Clinical results of four hundred and twenty four cases with chest trauma. *Ulus Travma Derg* 2003; 9: 267–74.
2. Yalcinkaya I, Sayor F, Kurnaz M, Cobanoglu U. Chest Trauma: Analysis of 126 Cases. *Ulus Travma Acil Cerrahi Derg* 2000; 6: 288–91.
3. Cangir AK, Nadir A, Akal M, Kutlay H, Özdemir N, Güngör A ve ark. Toraks travmasi: 532 olgunun analizi. *Ulus Travma Derg* 2000; 6: 100–05.
4. Allen GS, Cox CS Jr. Pulmonary contusion in children: diagnosis and management. *South Med J* 1998; 91: 1099–106.
5. Blostein P, Hodgman C. Computed tomography of the chest in blunt thoracic trauma: results of a prospective study. *J Trauma* 1997; 43: 13–18.
6. Lomoschitz FM, Eisenhuber E, Linnau KF, Peloschek P, Schoder M, Bankier AA. Imaging of chest trauma: radiological patterns of injury and diagnostic algorithms. *Eur J Radiol* 2003; 48: 61–70.
7. Zinck SE, Primack SL. Radiographic and CT findings in blunt chest trauma. *J Thorac Imaging* 2000; 15: 87–96.
8. Trupka A, Waydhas C, Hallfeldt KK, Nast-Kolb D, Pfeifer KJ, Schweiberer L. Value of thoracic computed tomography in the first assessment of severely injured patients with blunt chest trauma: results of a prospective study. *J Trauma* 1997; 43: 405–11.
9. Schild HH, Strunk H, Weber W, et al. Pulmonary contusion: CT vs plain radiograms. *J Comput Assist Tomogr* 1989; 13: 417–20.
10. Clark GC, Schecter WP, Trunkey DD. Variables affecting outcome

in blunt chest trauma: flail chest vs. pulmonary contusion. *J Trauma* 1988; 28: 298–304.

11. Cohn SM. "Pulmonary contusion: review of the clinical entity". *J Trauma* 1997; 42: 973–99.
12. Ullman EA, Donley LP, Brady WJ. Pulmonary trauma emergency department evaluation and management. *Emerg Med Clin North Am* 2003; 21: 291–13.
13. Allen GS, Cox CS . Pulmonary contusion in children: Diagnosis and management. *Southern Med J* 1998; 12: 1099–106.
14. Miller PR, Croce MA, Bee TK, et al. ARDS after pulmonary contusion: accurate measurement of contusion volume identifies high-risk patients. *J Traum* 2001; 51: 223–28.
15. Wicky S, Wintermark M, Schnyder P, Capasso P, Denys A. Imaging of blunt chest trauma. *Eur Radiol* 2000; 10: 1524–38.
16. Sutyak JP, Wohltmann CD, Larson J. Pulmonary contusions and critical care management in thoracic trauma. *Thorac Surg Clin* 2007; 17: 11–23.
17. Keough V, Pudelek B. Blunt chest trauma: review of selected pulmonary injuries focusing on pulmonary contusion. *AACN Clin Issues* 2001; 12: 270–81.
18. Ullman EA, Donley LP, Brady WJ. Pulmonary trauma emergency department evaluation and management. *Emerg Med Clin North Am* 2003; 21: 291–13.
19. Wanek S, Mayberry JC. Blunt thoracic trauma: flail chest, pulmonary contusion, and blast injury. *Crit Care Clin* 2004; 20: 71–81.
20. Lucid WA, Taylor TB. "Thoracic trauma", in Strange GR: Pediatric Emergency Medicine: A Comprehensive Study Guide. New York: McGraw-Hill, Medical Publishing Division, 2002; 92–100.
21. Gavelli G, Canini R, Bertaccini P, Battista G, Bnà C, Fattori R. Traumatic injuries: Imaging of thoracic injuries. *Eur Radiol* 2002; 12: 1273–94.
22. Kishen R, Lomas G. "Thoracic trauma", in Gwinnutt CL, Driscoll P: Trauma Resuscitation: The Team Approach. *Informa Healthcare* 2003; 55–64.
23. Fry DE. "Surgical infection", in O'Leary JP, Tabuenca A, Capote LR: The Physiologic Basis of Surgery. Hagerstown, MD: Lippincott Williams & Wilkins, 2007; 241.