Efficacy of Follow-Up Evaluation in Penetrating Thoracic Injuries: 3- vs. 6-Hour Radiographs of the Chest

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Abstract—Pneumothorax (PTX) in patients with penetrating thoracic trauma is routinely ruled out with serial chest radiographs (CXRs). This study examined the efficacy of a shortened time period between initial and follow-up radiographs. Patients with penetrating torso injuries treated at a Level-1 trauma center received a CXR during their initial evaluation. If no pneumothorax or hemothorax was noted, and the patient did not require immediate admission to the Intensive Care Unit or operating room, a repeat chest film was taken at 3 and 6 h. Findings were treated as clinically indicated, and patients were discharged home if the last radiograph revealed no evidence of pathology. Over a 15-month period, 116 patients were evaluated for penetrating thoracic injuries (93 stabbings, 23 gunshot wounds) and had no pneumothorax detected on initial CXR. Two patients had pneumothorax detectable only by computed tomography. One patient had a normal initial CXR, but developed a PTX on the 3-h film, requiring tube thoracostomy. No patients developed pneumothorax detectable only by computed tomography. One patient had a normal initial CXR, but developed a PTX on the 3-h film, requiring tube thoracostomy. No patients developed a PTX on the 6-h study that was not present on the initial or 3-h CXR. In conclusion, extending the time between initial and final CXRs to 6 h in patients with penetrating thoracic trauma provided no additional information that was not available on the 3-h film. © 2001 Elsevier Science Inc.

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INTRODUCTION

Pneumothorax (PTX) is a major complication and cause of morbidity and mortality following penetrating injuries of the chest. Complications from apparently minor wounds in asymptomatic patients are well-documented (1). The incidence of delayed pneumothorax resulting from such injuries has been reported to be as high as 12% (2). In most centers, the management of asymptomatic patients without evidence of pneumothorax on initial chest X-ray (CXR) study is observation with follow-up CXR. Although most authors agree on observation and follow-up study with serial CXRs, the suggested time interval between such studies and the duration of hospital observation remains uncertain, ranging from 6 to 48 h (2–5). Such a lapse between radiographs can result in crowded hallways and examination rooms in a busy Emergency Department (ED) or trauma center or impatient trauma victims leaving prior to their final CXR. Reducing this time interval to 3 h has been proposed recently (5). The objective of this study was to evaluate whether a radiograph of the chest taken 3 h after the initial CXR is as reliable as a 6-h radiograph in detecting delayed pneumothorax as a result of penetrating trauma to the thorax.
MATERIALS AND METHODS

This is a descriptive, prospective study of all trauma patients admitted to the University of Miami/Jackson Memorial Hospital’s Ryder Trauma Center (a Level-1 trauma center in Dade County, Florida) with penetrating injuries (stab and gunshot wounds) of the thorax during the period March 1997 to June 1998. All patients with wounds bounded by the clavicles and base of the neck superiorly and costal margin and iliac crest posteriorly were included. Every patient received a thorough physical examination and a baseline (zero hour) anteroposterior expiratory radiograph of the chest. Patients who were asymptomatic on arrival to the trauma center and who were without any evidence of pneumothorax or hemothorax by the initial radiograph of the chest underwent follow-up expiratory anteroposterior views of the chest at 3 and 6 h. Wounds were irrigated and debrided and sutured as needed. A computed tomography (CT) scan was done only if intra-abdominal injury was suspected. Patients were discharged home if the results of the physical examination and follow-up radiographs were negative. All patients were telephoned the day after their injury and given follow-up appointments with the trauma clinic for re-evaluation.

RESULTS

Over a 15-month period, a total of 116 patients sustained penetrating thoracic injuries with no evidence of pneumothorax or hemothorax by initial (zero hour) CXR examination (Table 1). These patients ranged in age from 10 to 68 years old and included 100 men (86%) and 16 women (14%). Ninety-three patients (80%) were victims of stab wounds, and 23 (20%) were recipients of gunshot. No gunshot wound patients in this study were recipients of a shotgun injury. Twenty-two patients sustained multiple penetrating injuries to the thorax: three were victims of shootings, and 20 sustained stab wounds.

Six patients left against medical advice (AMA) before completion of all three CXRs (Table 2), two having received the initial film only and four of whom completed the initial two studies. None demonstrated a pneumothorax on the available films. Two of the patients (one from each group) were seen in follow-up clinic within 5 days of injury, and neither demonstrated historical, clinical, or radiographic evidence of a pneumothorax. The remaining four patients who left AMA before completion of the full series were lost to further follow-up.

Two patients had a pneumothorax detectable only by CT scan and not seen on plain radiograph. One of these remained insignificant on follow-up studies and, by our current policy, was not treated with tube thoracostomy, whereas the other enlarged and required a chest tube. These patients were excluded from further study because of the presence of a detected pneumothorax.

Twenty-two patients received only the initial and 3-h CXR. Nine patients were admitted to the hospital before the 6-h time interval, but received in-house follow-up radiographs within 24 h of the injury; all were negative for pneumothorax. One patient left AMA but returned for follow-up visit, with no evidence of having sustained a pneumothorax. Three patients leaving AMA were lost to follow-up. One patient was discharged to jail with no subsequent problems. Eight additional patients were discharged before the 6-h study, four of whom demonstrated no evidence of pneumothorax on follow-up visit, and four of whom were lost to follow-up.

Eighty-seven patients completed radiograph studies at times zero, 3 h, and 6 h. One patient had a normal baseline CXR but demonstrated a PTX on the 3-h film, requiring tube thoracostomy. None of the remaining 86 patients developed a PTX on the 6-h study. Fifty-three were discharged home, and 33 were admitted to the

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<th>Table 1. Distribution of Injuries Relative to Mechanism of Injury, Anatomic Location, and Delayed Complications (PTX = pneumothorax).</th>
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<th>Table 2. Detection of Pneumothorax (PTX) by Initial, 3-h, and 6-h Chest Radiographs (CRX) and Those Leaving Against Medical Advice (AMA) Prior to Complete Series</th>
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<td>Group</td>
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hospital for other reasons. None developed a delayed pneumothorax.

During the same time period, an additional 111 victims of penetrating thoracic trauma were diagnosed with pneumothorax on the initial CXR. In combination with the study group, if the baseline and 3-h films are considered together as components of the same screening strategy, then their collaboration accounted for 112 true positive examinations. Two pneumothoraces escaped detection at the initial X-ray study and were detected by CT scan performed for other reasons. These may have become evident at the 3-h film, but can be considered false negative by the composite baseline 3-h screen. No patients were falsely reported to be positive, and a total of 109 patients were found to be truly negative by imaging studies subsequent to the baseline examination. Viewed in this manner, sensitivity was 98%, although this figure rises to 100% when only clinically significant pneumothoraces are considered. The data likely underestimate sensitivities because CT scan-detected pneumothoraces were not followed to the 3- and 6-h studies. With no false-negative results, specificity was 100%. Positive and negative predictive values were 100% and 98%, respectively.

**DISCUSSION**

The management of asymptomatic victims of penetrating injuries to the thorax has continued to evolve over the past two decades (2,3,6,7). Patients without evidence of pneumothorax on initial chest X-ray studies are now simply observed and studied with follow-up chest X-ray studies sometime after their arrival in the ED. According to Muckart, two issues remain controversial among physicians treating such injuries: (1) how to identify those most likely to go on to develop a delayed pneumothorax and require drainage and (2) what is the appropriate length of time to observe these patients prior to discharge (8). Some authors have concluded that physical examination, and number and location of wounds are unreliable predictors, and advocate monitoring patients for 48 h or more to guard against delayed complications (8). Others have shown that it may be just as safe and more cost effective to discharge patients after a normal second CXR has been obtained at 6–8 h after initial presentation (2,4,5). The most recent literature suggests that patients having a normal physical examination and normal initial chest film should not be admitted, but rather should remain in the holding area of the ED and be discharged after 3–4 h of observation (5,6).

Most authors agree on observation with serial CXRs, but the 6-h or longer lapses between radiographs can exacerbate overcrowding in the stressed EDs and trauma centers seen today. Also, in this subset of trauma patients, such a delay may lead to patients becoming impatient and leaving prior to final X-ray study. In our study, two patients did not stay beyond the initial evaluation, and four would not wait beyond the 3-h CXR. This noncompliance was also clearly demonstrated by the typically poor turnout for follow-up trauma clinic visits. However, we made the assumption that being the only Level-1 trauma center and the only public health facility in Miami-Dade County, as well as the initial point of treatment should any delayed complications occur, such patients would likely return to our facility and be accounted for in the study. No unscheduled return visits were encountered. Additionally, all patients discharged home from the trauma center after initial work-up are contacted by telephone the following day by trauma center personnel. No patients reported respiratory difficulties.

With the increased use of CT scans over the past two decades, we have discovered pneumothoraces too small to be detectable on plain radiographs. Though at least two studies conflict regarding the management of CT scan-detectable-only pneumothoraces for patients receiving positive-pressure ventilation, the standard of care would not support tube decompression of patients with such minute pneumothoraces not undergoing positive-pressure ventilation (9,10). As mentioned previously, only patients requiring CT scans for possible associated injuries underwent a CT scan. Two patients had CT scan-detected-only pneumothoraces, one of which was substantial enough to be treated with tube decompression, the other remaining undetectable on standard follow-up CXRs. These two patients were excluded from further study because one received a chest tube and the other fell out of protocol. One may argue that the CT scan is much more sensitive than radiographs, though in many cases, it may be overly sensitive. If the CT scan-detected pneumothorax is clinically irrelevant, the added time and expense to scan all penetrating chest trauma is not warranted.

Though our study included only patients who had no evidence of pneumothorax on the initial radiographs, physicians are often confronted with patients with “small” pneumothoraces and the question of whether tube thoracostomy is indicated. Muckart demonstrated an 8% incidence of worsening pneumothorax, hemothorax, or both—requiring decompression—on delayed radiographs in patients with an initial positive study (8). Twenty-one percent of those with an initial hemopneumothorax worsened, as opposed to 12.5% with hemothorax alone, and 2.5% with only pneumothorax. Because of the long-term complication of fibrosed hemothorax, it is unwise to allow any hemothorax to remain undrained. Johnson similarly reported a 6.9% incidence of interval
enlargement of small pneumothoraces subsequently requiring tube decompression (11). Small pneumothoraces, therefore, may be amenable to in-patient observation and serial CXRs or may be aspirated and/or decompressed with small chest tubes or pig-tail catheters.

CONCLUSION

Our study suggests that extending the time between initial and final CXRs to 6 h in the asymptomatic patient with penetrating thoracic trauma provides no additional information that is not available on the 3-h film. These patients can be safely discharged home if the initial and 3-h follow-up CXRs are negative for any pneumothorax or hemothorax.

REFERENCES