THE VALUE AND PROGNOSTIC ROLE OF THE CT SCAN VERSUS CHEST RADIOGRAPHY IN THE FOLLOW-UP OF INTUBATED BURN PATIENTS WITH POSSIBLE INHALATION INJURY

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SUMMARY. The admission and follow-up chest radiographs as well as the follow-up CT scans of 13 burn patients admitted to our clinic requiring ventilatory support were analysed for signs of inhalation injury and pulmonary complications. The findings were compared with the results of the clinical examination, the blood gas tests, and bronchoscopy. Eleven out of the 13 patients underwent bronchoscopy revealing inhalation injury. The CT scan detected pleural effusion in two patients with a normal chest radiograph. In two patients the CT scan detected asymmetrical expansion between the right lung and the left. In one patient soft tissue oedema made evaluation of the chest radiograph impossible, while the CT revealed bilateral pleural effusions and consolidations or atelectasis in both the lower lobes. In one patient the CT scan detected oedema of consolidatory pattern in every lobe (superior-middle-inferior), while the image in the chest radiograph was not similar. CT identified an area of consolidation in one patient in the right middle lobe with a normal chest radiograph. The results of the CT scan correlated with the clinical course and blood gas determinations, while similar findings in the chest radiograph were observed at a later stage. In conclusion, compared to chest radiographs, the CT scan often yielded additional information in the follow-up of intubated burn patients with inhalation injury. It can be performed in order to confirm and/or more precisely define the full extent of lung injury and is also feasible in patients who are critically ill and hard to move.

Introduction

Inhalation injury is the main reason for the intubation of burn patients. Diagnosis of inhalation injury is based on the history (closed space fire, loss of consciousness at the accident site), the clinical examination (facial burns, pharyngeal burns, carbonaceous sputum, wheeze, hoarseness, dyspnoea), and laboratory tests (blood gas abnormalities, blood carboxyhaemoglobin levels above 10%). Tests that contribute to the diagnosis also include: i) a chest radiograph indicating interstitial or alveolar oedema, consolidations, and/or atelectasis; ii) bronchoscopic evidence of erythema, laryngeal oedema, and tracheal oedema; and iii) abnormal perfusion-ventilation Xe\(^{133}\) scan.\(^1\)

It is well known that chest radiographs are insensitive indicators of airway and parenchymal lung damage\(^2\) following acute inhalation injury and burns, as pulmonary oedema or consolidations usually develop at a later stage.\(^3\)

The purpose of this study is to demonstrate that compared to chest radiographs, CT can be an early detector of inhalation injury complications and also that CT scan patterns correlate with the clinical course and justify it. It is also useful in the early diagnosis of parenchymal and pleural abnormalities during the follow-up of intubated patients with inhalation injury. Finally, it can detect the full extent of complications that are often underestimated by chest radiography.

Material and methods

All patients admitted to our burns unit following acute inhalation injury and burns and requiring ventilatory support between January and December 2002 were subjected to serial chest radiographs and CT scan during the first days of hospitalization. The CT scan and chest radiograph were examined by an experienced radiologist for signs of inhalation injury, including atelectasis and oedema of consolidatory or nodular pattern. The results were analysed and compared with the findings of the clinical examination and blood gases.

The patients’ medical records were reviewed and the percentage of body surface area burns was recorded, as also the results of bronchoscopy and of the ear, nose, and throat (ENT) examination, the indications for intubation, and blood gas determinations. Patients in whom heart failure or fluid overload might have been the cause of the radiological abnormalities were excluded.\(^4,5\)

Results

Thirteen patients fulfilling our criteria were included in the study (3 female, 10 male). The age range was from 22 to 77 years. The percentage of body surface area burns ranged from 22 to 95%. Five patients were referred to our unit from peripheral units and were already intubated on
admission. Six patients were intubated following the results of the ENT examination (finding of soot and oropharyngeal oedema), as also two patients following gradual aggravation of blood gas determinations and the development of pulmonary insufficiency.

Inhalation injury was revealed by bronchoscopic examination in 11 out of the 13 patients. The other two patients did not undergo fiberoptic bronchoscopy because they were hepatitis C positive (owing to the infection control policy in our hospital, where there is only one common bronchoscopic device).

The radiographic spectrum of pulmonary complications in CT scans was: atelectasis, opacities of patchy, homogenous, or ground glass pattern, asymmetrical expansion of the two lungs, and pleural effusions.

The manifestations of pulmonary complications in chest radiographs were: atelectasis, patchy or homogenous opacities, and pleural effusions.

The following data were recorded on the basis of a comparison of the CT scans with the same-day chest radiography findings:

- Pleural effusions were observed on the CT scan in two patients with a normal chest radiography.
- The CT demonstrated asymmetrical expansion of both lungs in two patients.
- In one patient soft tissue oedema made evaluation of the chest radiograph impossible, while the CT detected bilateral pleural effusions and consolidations and atelectasis in both bases.
- Oedema of consolidatory pattern and atelectasis were observed in every lobe on CT, with no similar image in the chest radiograph in one patient.
- Many small consolidations, the largest being in the posterior half of the right middle lobe, were detected on CT in one patient while the chest radiograph was normal.

The findings of the CT scans were also consistent with the blood gas determinations:

- In two patients with respiratory acidosis and hypoxaemia the CT scan detected massive consolidations and atelectasis.
- In two cases the CT demonstrated massive consolidations and atelectasis as well as blood gas hypercapnia and hypoxaemia.
- One patient had normal blood gases and a normal CT scan.
- Two patients had hypoxaemia following diffuse patchy infiltrates in both lungs.
- In one case with diffuse patchy infiltrates, hypoxaemia and metabolic acidosis were noticed.
- One patient had respiratory alkalosis in the blood gases and focal infiltrates compatible with pneumonia.
- Seven of our patients gradually developed respiratory insufficiency and eventually died.

Discussion

It is well known that there is a gap in our diagnostic examinations regarding the evaluation and follow-up of inhalation injury.

Fiberoptic bronchoscopy reliably defines the extent of upper airway injury, while there is no method that diagnoses parenchymal damage at an early stage. The evaluation of possible parenchymal damage at an early stage is based on the presence of hypoxaemia, hypercapnia, and high levels of carboxyhaemoglobin. The Xe can provide more accurate information, but this examination is limited by the availability of the isotope and by its invasiveness.

![Fig. 1a](image1.png) - Many small scattered lesions, the largest being located in the posterior part of the right middle lobe, and small bilateral pleural effusion.

![Fig. 1b](image2.png) - Normal chest radiograph.
There is therefore still a need for an easy, reliable method to determine at an early stage parenchymal damage and pulmonary complications in the follow-up.

According to the literature, chest radiography can detect late complications and well-organized pulmonary abnormalities,9,10 while the CT scan can demonstrate even minimal parenchymal damage (1 mm in diameter) and define the injury’s full extent. This is important in inhalation injury, as this causes many poorly scattered lesions of small diameter that cannot be detected in a chest radiograph (Figs. 1a,b). It can also be used in the diagnosis of complications in radiographically non-apparent areas such as the lower parts of the inferior lobes and the posterior areas of the pulmonary fields. These facts agree with our findings in one case. This patient’s CT scan was compared with the chest radiograph on the same day (Figs. 1a,b).

In critically ill patients who are hard to move, in whom chest radiographs are usually performed with a portable device, the quality of the images is questionable. Also, soft tissue disorders such as obesity or oedema cause additional problems in the evaluation of the radiographs. The CT scan overcomes these problems, as we observed in the examination of one of our patients (Figs. 2a,b).

An additional indication for the use of CT scan is the differentiation between parenchymal and pleural abnormalities.10 This agrees with our findings in one patient (Figs. 3a,b). In these cases the CT scan can be used for guidance of drainage of the effusion and helps in the improvement of the clinical picture. As we also observed in two cases, the CT scan can demonstrate even small pleural effusions that are non-apparent in the chest radiograph.

Finally, the findings of the CT scans correlate with pulmonary function as expressed by the blood gas results. The co-evaluation of all these parameters can enable us to predict the evolution of the disease and intervene therapeutically, using the most appropriate methods.
Conclusions

The results of our study confirm the value of the CT scan in the diagnosis and follow-up of intubated patients with inhalation injury. Compared to the chest radiograph, it is more reliable for the detection of pulmonary abnormalities at an early stage, as also for the demonstration of pulmonary complications during the follow-up.

On the basis of our findings, we suggest that the CT scan could be added to the protocol of the treatment of intubated patients with inhalation injury as an examination of significant diagnostic and prognostic value.

BIBLIOGRAPHY


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