

CT guided transthoracic catheter drainage of intrapulmonary abscess

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Abstract

Objective: To determine the efficacy of CT- guided transthoracic catheter drainage of intrapulmonary abscess considering success rate versus complications.

Methods: This prospective study was carried out at radiology department of Al-Noor Specialist Hospital, Makkah, Saudi Arabia, from 1.1.2003 to 31.12.2005. Nineteen patients were selected for CT guided percutaneous drainage. Under CT guidance catheter placement was carried out using Seldinger technique.

Results: Nineteen patients with lung abscess were selected for the percutaneous CT guided drainage. Eight (42.105%) patients encountered no complications and lung abscess completely resolved with no residual cavity. Five (26.31%) patients developed pneumothorax, which was the most common complication of this study. These patients were kept under observation and followed-up by chest X-rays. Three (15.78%) had mild pneumothorax, which resolved and needed no further management, while two (10.52%) patients developed moderate pneumothorax and chest tube was inserted. Two (10.52%) patients developed mild haemoptysis which resolved within two hours, hence, no further management was required. Two (10.52%) patients had residual cavity and surgery was performed. Congenital cystic adenomatoid malformation (CCAM) was found in both cases. Two patients out of nineteen patients (10.52%) developed bronchopleural fistula and were operated. No mortality occurred during or after the procedure.

Conclusion: CT allows optimal placement of catheter and hence enables safe and effective percutaneous evacuation of lung abscess. The morbidity and mortality of patients with percutaneous catheter drainage is lower than with surgical resection. Hence, CT guided drainage should be considered the first therapeutic choice in most patients of lung abscess who do not respond to medical therapy (JPMA 59:703; 2009).

Introduction

Lung abscess is defined as a localized area of liquefactive necrosis of the pulmonary tissue and formation of cavities containing necrotic debris or fluid caused by microbial infection.

Although 80-90 % of pyogenic lung abscesses are now successfully treated with antibiotics,¹ occasionally this conservative therapy may fail,²⁻⁴ which could be due to the virulence of the responsible pathogens or failure to achieve an adequate concentration of antibiotics within the abscess cavity.^{1,5,6} Severe underlying lung disease and decreased lung compliance may play a role in the failure of an abscess cavity to drain spontaneously and hence failure of medical therapy.^{1,5} Image guided percutaneous catheter drainage of intrapulmonary air and fluid collections is an alternative treatment option with less morbidity and mortality than surgical resection of intrapulmonary lung abscess of those patients who do not respond to medical therapy. The use of CT allows optimal characterization of intrapulmonary collection, optimal catheter placement and enables safe and effective evacuation.

Materials and Methods

This prospective study was carried out at radiology department of Al-Noor Specialist Hospital, Makkah, Saudi Arabia, from 1.1.2003 to 31.12.2005. Nineteen patients were selected for CT guided percutaneous drainage, which were fulfilling the following inclusion criteria formulated for the drainage of the lung abscess:

- ◆ Persistent sepsis 1 week after initiation of antibiotic therapy,
- ◆ The abscess was larger than 4cm, or
- ◆ The abscess increased in size while the patient was on medical therapy.⁷

Size of the lung abscess was 4-6 cm in 10 patients and 6-8 cm in 9 patients. Five patients had abscess at left lower lobe, twelve patients at right lower lobe, one patient had it at right middle lobe and one patient at lingular segment of left upper lung. In 14 patients, abscess was peripherally located, adjacent to pleura and in the rest deeply placed with intervening lung in between.

Exclusion criteria of patients were:

When abscess contained thick viscous, organized tissue, abscess was multiloculated and abscess had a thick

noncollapsible wall.^{1,4,8,9}

Technique:

Informed consent was obtained before starting the procedure.

Before undertaking the procedure of drainage, CT chest was performed to determine the site, size, wall characteristics and relations of the lung abscess to adjacent lung parenchyma.

Drainage of the abscess was performed using Seldinger technique.⁹ Although direct puncture of the abscess cavity with the single puncture trocar drainage system often saves time, the Seldinger technique, with placement of catheter over a guidewire, allows more control and may decrease the complication rate.^{8,9}

Patient positioning and decision of site of catheter placement was considered important for safe and successful abscess drainage. Catheter was placed so that its tip was lying in gravity dependent position.⁹ Avoidance of normal lung can prevent development of a bronchopleural fistula or pneumothorax.⁸ Once the puncture site was cleaned and anesthetized, 16 to 18-gauge lumbar puncture (LP) needle was placed through the chest wall into the abscess cavity until pus or

air came out. This was followed by introduction of a 0.035 guide wire through the needle and over the guidewire, tract was dilated with dilators. Typically a 12F to 14F all purpose catheter was inserted into the abscess cavity and secured in the place by adhesive skin disc (Hollister, IL) or simply by suturing.^{8,9} Catheter was connected to under water drainage system, and to continuous wall suction at 20 to 30 cm H₂O. Decompression was achieved slowly to avoid rupture of a vessel or a Rasmussen pseudoaneurysm was incorporated in the abscess wall.¹⁰

Periodic irrigation of the catheter with 5 to 15 ml of saline was done if pus was thick to facilitate its drainage.^{8,9}

Repeat selected axial images were taken of CT scan to confirm the correct catheter placement. Following the procedure, a chest radiograph was obtained as a baseline X-ray to enable follow-up comparison. Catheter was left in place until drainage (fluid or air) stopped. Patients were followed till complete closure of abscess cavity or decision of surgery was taken because of either bronchopleural fistula formation or due to non closure of abscess cavity.

Results

Nineteen patients with lung abscess were selected in

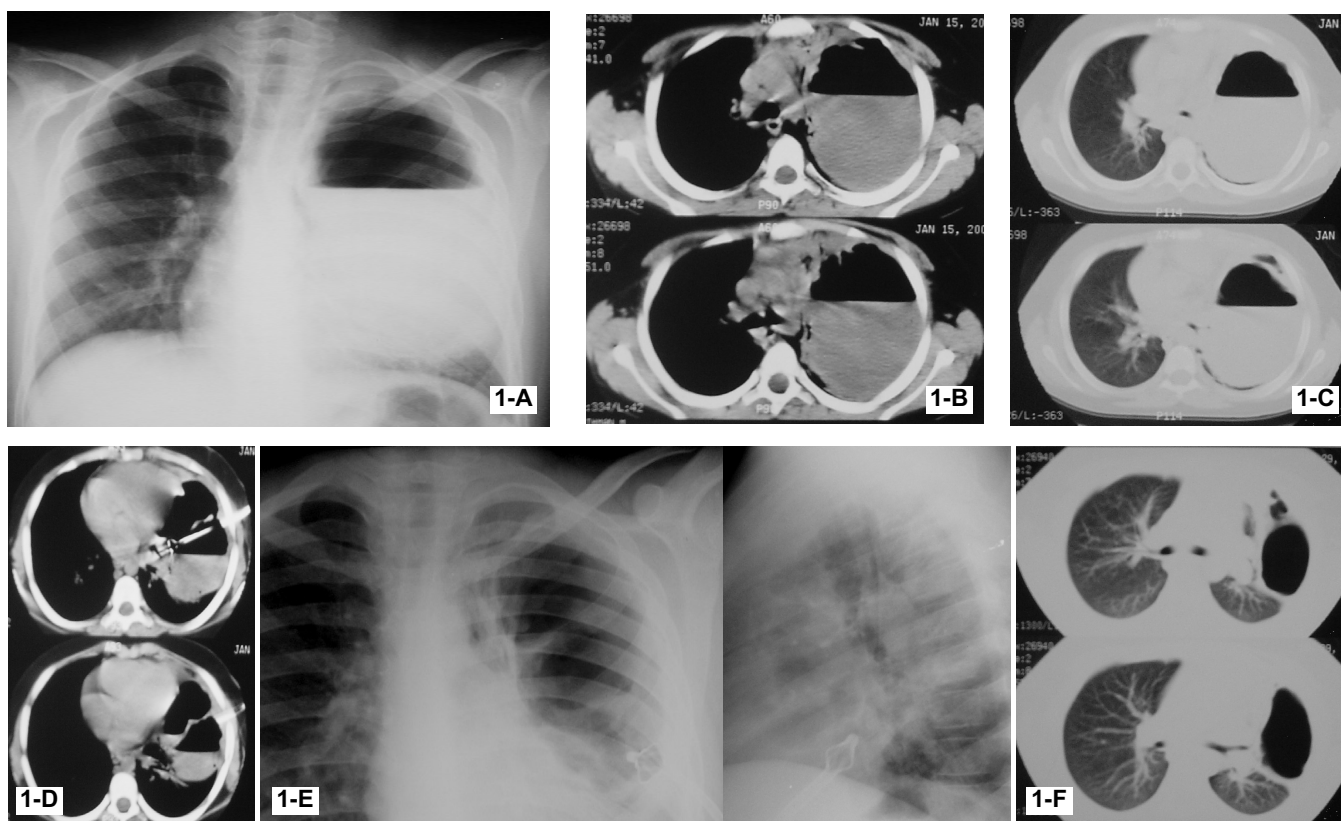


Figure-1: 9-year-old boy with left lung abscess. He had persistent fever 1 week after institution of systemic antibiotic and postural drainage. [A] Chest PA, [B&C] Axial CT scan mediastinal and lung window shows large abscess with air-fluid level almost filling the left hemithorax. [D] CT after percutaneous drainage shows immediate decrease in fluid and size of lung abscess. The patient had a rapid symptomatic response to abscess drainage. [E] Follow up Chest PA and left lateral 3 days after the procedure show almost complete drainage of the fluid. [F] CT scan 4 weeks later and after catheter removal, show residual cavity with re-expansion of the lower lobe.

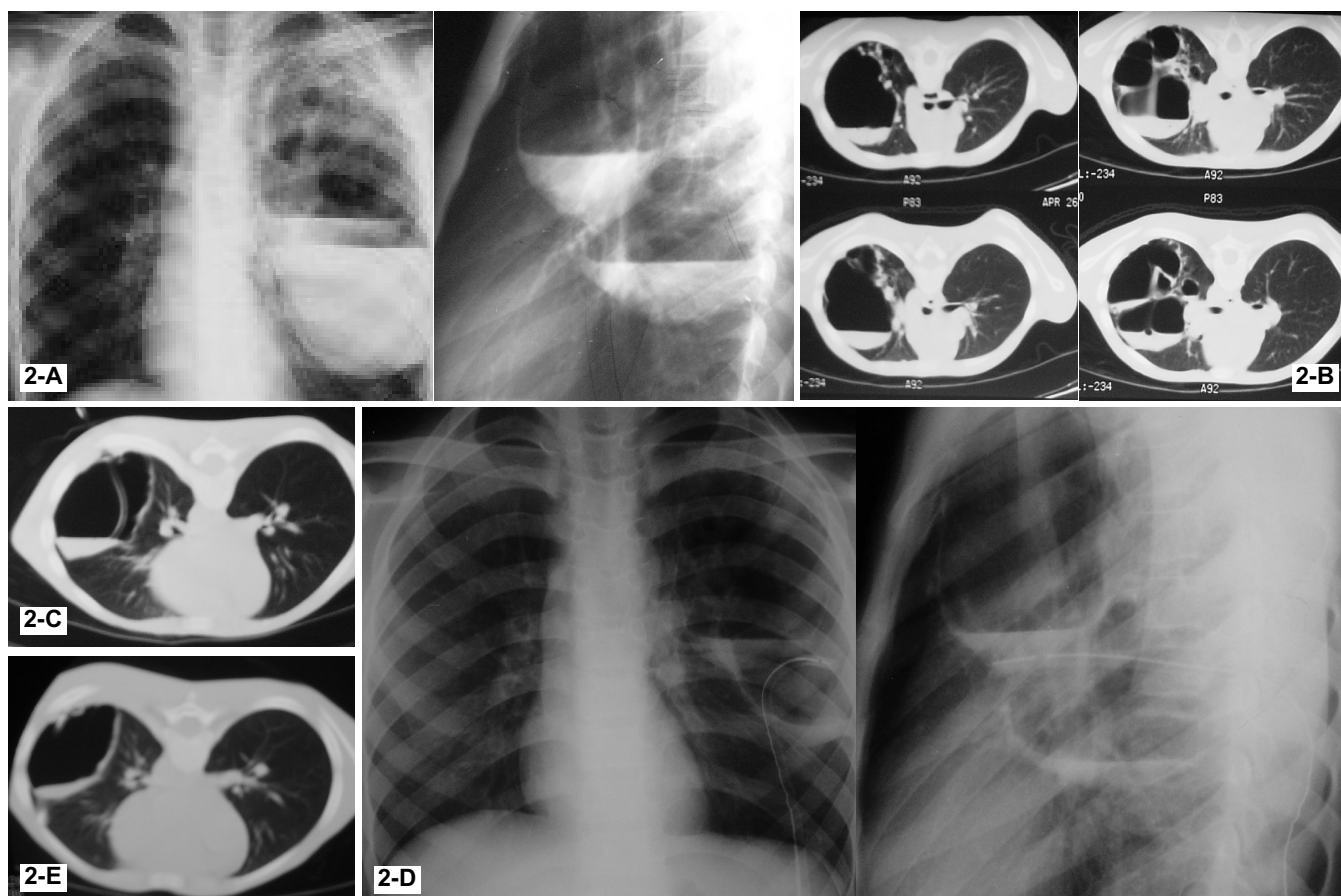


Figure-2: 39-year-old male with lung abscess and failed medical treatment. [A] Chest PA and left lateral, [B] Sequential axial CT slices, shows multilocular abscess with double air-fluid level. [C] CT scan after catheter placement show rapid decompression of the abscess cavity and reduced fluid content. [D] 2nd day follow up chest PA and left lateral show decreased abscess cavity and fluid content. Patient had marked clinical improvement with rapid defervescence. [E] Follow up CT scan show catheter tip outside the cavity (curved arrow) for which CT guided re-positioning is done.

Table: Complications occurring in 19 patients undergoing ct guided transthoracic catheter drainage of intrapulmonary abscess.

S No	Number of patients	Complications occurring during the procedure	Further management needed
1	8	None	-
2	3	Mild Pneumothorax	-
3	2	Moderate Pneumothorax	Tube thoracostomy
4	2	Bronchopleural Fistula	Surgery
5	2	Residual Cavity	Surgery*
6	2	Minor Hemoptysis	-

*Pathological examination revealed CCAM in both cases.

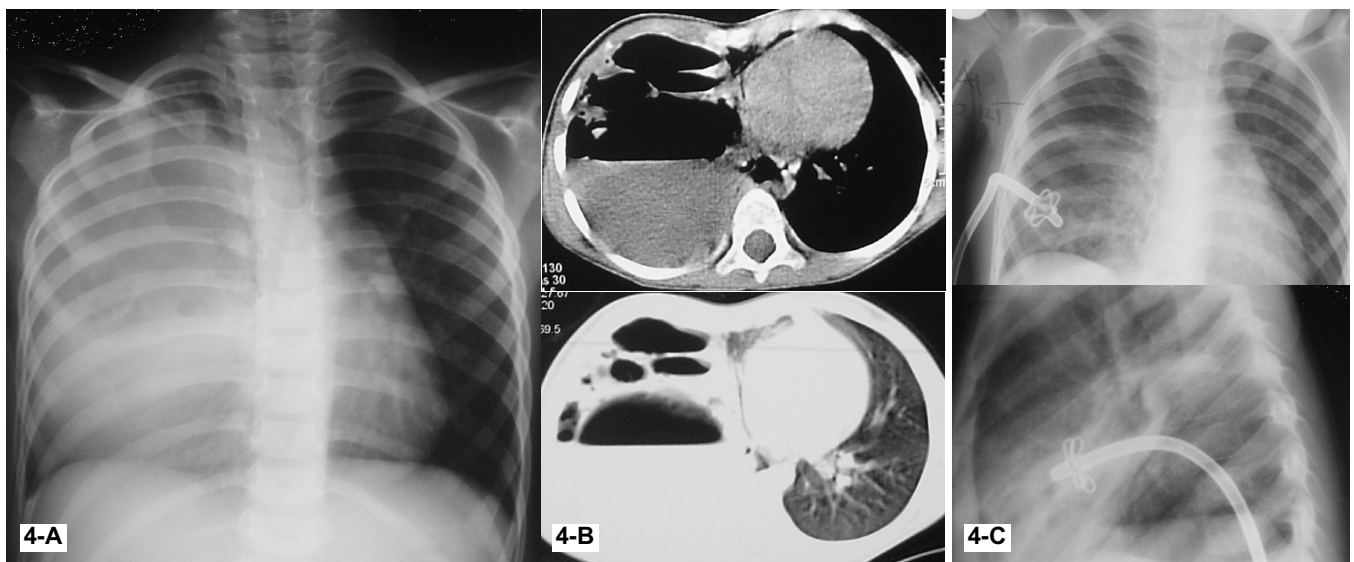
this study for the percutaneous CT guided drainage. Their age range was 5-70 years. They were 14 males and 5 females. Out of these nineteen patients, eight patients (42.105%) developed no complications during or after the procedure, and lung abscess was completely resolved with no residual cavity.

Five out of nineteen patients (26.31%) developed pneumothorax. These patients were kept under observation and followed-up by chest X-rays. Three of

them (15.78%) had mild pneumothorax, which resolved and needed no further management, while two patients (10.52%) developed moderate pneumothorax and chest tube was inserted, and these two patients were those who had deeply placed abscesses and normal lung tissue had to be traversed to acquire access to the abscess cavity. Patients with small and stable pneumothoraces were safely observed on bed rest with administration of supplemental oxygen.



Figure-3: 45-year-old male with right lung abscess and failed medical treatment. [A] Chest PA and right lateral show cavitary lesion with air-fluid level in right lower lobe associated with pleural effusion. [B] Axial CT scan before and after catheter placement. The pleural effusion was loculated. [C] Follow up Chest PA showed completely drained fluid and marked resolving of the abscess cavity.



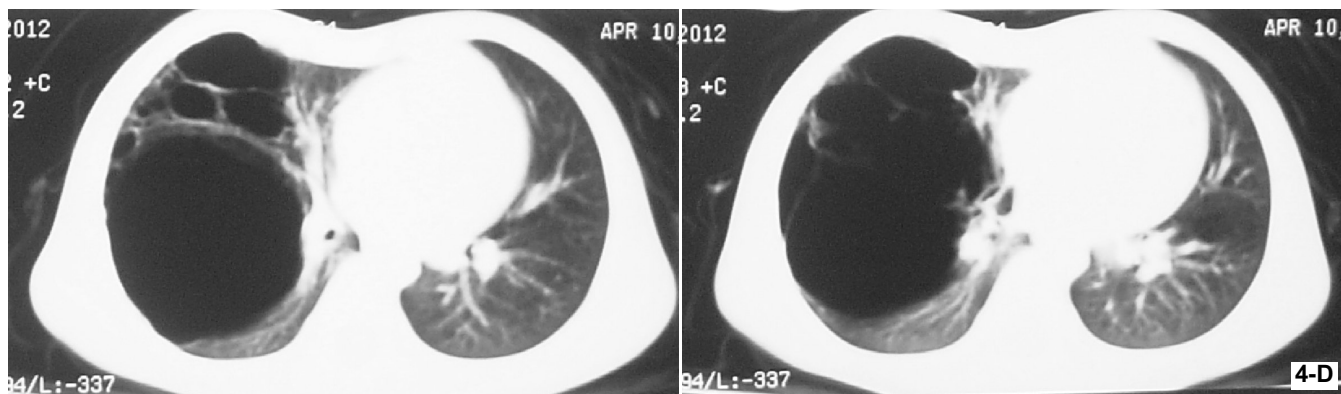


Figure-4: 5-year-old girl with right sided lung abscess. [A] Chest PA, [B] Axial CT scan show large multilocular cavitary lesion with air-fluid level occupying right hemithorax. [C] Follow up chest AP and lateral show residual air-fluid level with catheter in place. Patient's symptoms were completely resolved. [D] Follow up CT scan after 6 months show persistent residual cavity with re-expansion of the upper lobe. An underlying congenital lesion was suspected for which surgery was performed and revealed congenital cystic adenomatoid malformation.

Two out of nineteen patients (10.52%) developed mild haemoptysis, which resolved within two hours, hence, no further management was required.

Two patients (10.52%) had residual cavity left and surgery was performed in both cases. Both of these cases were identified as congenital cystic adenomatoid malformation (CCAM).

In eleven out of nineteen patients, complete resolution of abscess cavity occurred in 4 weeks, whereas in four patients it took 5 weeks. In two patients abscess cavity persisted till 8 weeks till they were operated and histopathological examination of the excised tissue revealed congenital cystic adenomatoid malformation. Two (10.52%) out of nineteen patients developed persistent empyema, not resolving by pleural catheter drainage. These patients were ultimately operated and found to have bronchopleural fistula formation (Figures 1 to 4). No mortality occurred during or after procedure.

Table summarizes the final results of percutaneous CT-guided drainage of lung abscesses in 19 patients.

Discussion

Lung abscess usually are caused by anaerobic bacteria and typically occur after aspiration. Consequently, they are seen more commonly in patients with altered levels of consciousness, seizures, gastro-esophageal dysmotility and poor dental hygiene.^{3,9} Most lung abscesses in paediatric patients are believed to develop secondary to bacterial pneumonia. Other predisposing factors for development of a lung abscess include, immunodeficiency or immunosuppression state caused by viral infection, severe systemic illness or steroid therapy. Less common

causes are cystic fibrosis, α -1 antitrypsin deficiency, anaesthesia and dental surgery.^{11,12} Medical therapy is the initial treatment and is curative in most patients.^{3,13} Surgical or percutaneous drainage is required in 11% to 21% of patients with lung abscess who fail to respond to medical therapy.^{14,16}

Image guided percutaneous catheter drainage is an alternative to traditional surgical management of lung abscess, and is safe and effective with less morbidity and mortality than surgical resection.^{8,17,18} Other advantages are rapid clinical and radiological improvement of pyogenic abscess which may avoid complications that can occur with prolonged and conservative treatment.^{1,8}

Percutaneous drainage of abscess is recommended when the patient has persistent sepsis 1 week after initiation of antibiotic therapy, the abscess is larger than 4cm or the abscess increases in size while the patient is on medical therapy.⁷ Size of the abscess is considered one of important criteria while deciding the choice of therapy and larger abscess size was shown to be associated with poorer prognosis and increased morbidity and possibly mortality.^{19,20}

Lung abscess may be drained using fluoroscopy or ultrasound guidance, but CT guidance was preferred in this study. Reasons being, CT is usually performed in all patients with lung abscess before transthoracic placement of the drainage catheter.^{3,8,13} CT is useful in evaluation of the intrathoracic abnormality and helps differentiate it from necrotizing pneumonia. This is important because catheter drainage of necrotizing pneumonia has proved to have a higher complication rate like bronchopleural fistula and pneumothorax.²¹ CT is optimal in determining

the wall thickness of an abscess, contents of an abscess and its relationship to the adjacent lung and pleura. More over, any obstructing foreign body or endobronchial neoplasms can also be visualized. Before considering the failure of medical therapy and the need of percutaneous transthoracic drainage it is important to rule out bronchial obstruction and bronchogenic malignancy as these are indications of surgical resection.^{22,23} Follow-up CT studies after placement of percutaneous catheter allow optimal assessment of the adequacy of pus drainage and help in determining whether an additional catheter is required.⁸

In this study Seldinger technique was used, but in literature both Seldinger and Trocar techniques have been used. Relating to relative safety there is no published study that has analysed which of the two techniques is safer for draining lung abscess. Erasmus et al.⁹ seem to favour Seldinger technique, stating that although direct puncture of the abscess cavity with trocar drainage system often saves time, the Seldinger technique with placement of catheter over guide wire allows more control and decreases the likelihood of complications. Van Sonnenberg et al.⁸ have also cautioned that trocar technique may be quite safe, using it, nevertheless may cause higher incidence of undesirable trauma to the lung. Klein JS et al.³ have discussed medico-legal aspects of death occurring in a 25 year old patient, 4 days after trocar guided drainage of lung abscess. On the other hand proponents of the trocar method such as Silvermann et al.²⁴ believe that the trocar method is superior as exchange of guidewire and dilators during Seldinger technique increases the likelihood of pneumothorax and advancing catheter intercostally through thickened pleura can cause buckling and kinking of guidewire and catheter. Hence the choice of technique is made by the specific radiologist performing the procedure.

Duration of complete closure of cavity is variable and has been reported to occur as early as 4 days⁷ or as long as 12 weeks,² but usually it takes 4 to 5 weeks^{1,5,10} as occurred in our study.

Keeping in view the complications which occurred during or after the procedure, most of them were minor and required no further management which means that success rate of this procedure is 78.94% and these patients were saved from surgery. No mortality occurred during or after the procedure. These results are comparable to the the results of largest series published to date. Van Sonnenberg et al.⁸ reported successful CT guided percutaneous lung abscess drainage in 19 patients, and surgery was avoided in 16 patients (84% success rate), surgery was performed in three patients because of adjacent organized pleural tissue that could not be drained

via percutaneous catheters. Complications that occurred in Van Sonnenberg study were haemothorax (occurred in one patient, who required chest tube for drainage), clogging of catheter (occurred in two patients, who required catheter exchange) and transient elevation of intracerebral pressure (one patient).

Procedure related complications could be avoided preferring Seldinger technique than Trocar.²⁵ Puncture site should be chosen so that needle and catheter should traverse contiguous abnormal lung and pleura to reach abscess and avoidance of normal lung can prevent development of bronchopleural fistula or pyopneumothorax.⁸

Failure of the percutaneous drainage can occur when the abscess contains viscous, organized tissue, is multiloculated or has thick noncollapsible walls, hence it was selected as the exclusion criteria.^{1,4,8,9} Persistent aspiration can also result in failure of the procedure²⁶ hence when clinically suspected, barium swallow can be performed before procedure to prevent failure.

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