Review Article

An update on the drainage of pyogenic lung abscesses

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Abstract:

Most lung abscesses (80–90%) are now successfully treated with antibiotics; however, this conservative approach may occasionally fail. When medical treatment fails, pulmonary resection is usually advised. Alternatively, percutaneous transthoracic tube drainage or endoscopic drainage can be considered, though both remain controversial. In this communication, the medical literature focusing on percutaneous tube drainage efficacy, indications, techniques, complications, and mortality, as well as available data regarding endoscopic drainage are reviewed.

Key words:

Percutaneous drainage, pyogenic lung abscess, endoscpoic drainage

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Percutaneous transthoracic tube drainage was first described in 1938 for the treatment of tuberculous lung cavities.[1] It was later used routinely in the management of pyogenic lung abscesses before the antibiotic era and became the treatment of choice.[1,2] However, with the introduction of antibiotics, this procedure gave way to medical therapy. Although 80–90% of pyogenic lung abscesses are now successfully treated with antibiotics, this conservative therapy occasionally fails.[3-5] This may be due to the virulence of the responsible pathogens, failure to achieve an adequate concentration of antibiotics within the abscess cavity, and/or severe underlying lung disease that may play a role in the failure of the abscess cavity to drain spontaneously.[6,7] When medical treatment fails, pulmonary resection is usually advised. However, mortality rates from lung abscesses continue to be substantial, even with surgical therapy, ranging from 15 to 20%.[8-11] An alternative therapy in this context is percutaneous tube drainage (PTD). Currently, the role of PTD in the management of pyogenic lung abscess remains controversial. This procedure has not gained widespread popularity; it has been mainly reported in severely ill patients with lung abscesses, who are unable to tolerate lobectomy.[12] Another drainage procedure is endoscopic drainage (ED) of the parenchymal abscess cavities, which was first reported by Metras and Chapin in 1954.[13] ED is considered as an alternative to percutaneous drainage in patients who are coagulopathic, have airway obstruction, or have a fairly central abscess.

In this communication, we explore the medical literature focusing on PTD and alternative, potentially effective procedures. We identified and reviewed the English literature relating to this topic (January 1975 to December 2010) via a MEDLINE search using the following terms: Pyogenic lung abscess, treatment, percutaneous drainage, tube drainage, management, endoscopic drainage. Successful treatment was defined clinically as the control of sepsis and avoidance of surgical resection. Radiologically successful therapy was defined as resolution of signs of inflammation, namely, consolidation, pleural effusion, and cavities. The presence of a residual cavity did not indicate failure of drainage.

Percutaneous Tube Drainage

There have been 26 published studies of PTD in the English literature since 1975. However, none of these were controlled trials evaluating the role of PTD in the treatment of pyogenic lung abscesses. All the studies were case reports or case series. We excluded five studies (patients who were actually treated with pneumonostomy requiring operative rib resection or studies at the beginning of the antibiotic era).[4,14-17] The remaining 21 studies reported 124 cases, including 14 cases of secondary pyogenic abscess, 9 with pre-existing cysts and 5 with lung cancer. The remaining 110 patients had primary pyogenic abscesses.

The efficacy, complications, and mortality rate of PTD are summarized in Table 1. The success rate as defined above was 83.9% (104/124). The complication rate related to the procedure was found to be 16.1% (18/112). As a complication of the abscess, the overall mortality rate was estimated to be 4.0% (5/124).

Table 1: Efficacy, complications, and mortality of percutaneous tube drainage

Year	Study	No. of cases	Success rate (%)*	Complication rate (%)	Mortality rate (%)
1978	Vainrub *et al.*[6]	3	100	0	0
1978	Lawrence *et al.*[25]	1	100	0	0
1979	Aronberg *et al.*[41]	1	100	0	0
1982	Keller *et al.*[42]	1	100	0	0
1984	Weissberg *et al.*[12]	7	100	0	0
1985	Yellin *et al.*[18]	10	70	0	0
1985	Mengoli *et al.*[19]	3	100	0	0
1987	Crouch *et al.*[43]	4	100	NA	0
1987	Parker *et al.*[24]	6	83	50	0
1987	Rice *et al.*[20]	11	72.7	0	0
1987	Van Sonnenberg *et al.*[44]	4	75	0	0
1989	Ball *et al.*[45]	3	100	0	0
1990	Shim *et al.*[3]	5	100	0	0
1991	Van Sonnenberg *et al.*[23]	19	100	21	0
1992	Lambiase *et al.*[46]	2	100	0	0
1993	Ha *et al.*[26]	6	66.7	0	0
1996	Zuhdi *et al.*[47]	5	100	0	0
1997	Johnson *et al.*[48]	1	100	0	0
1999	Hoffer *et al.*[30]	5	80	40	0
1999	Hirshberg *et al.*[8]	8	37.5	NA	5 (62.5)
2009	Yonus *et al.*[29]	19	78.9	60	0
	Total	124	104/124 (83.9)	18/112 (16.1)#	5/124 (4.0)

*See text for definition. #In two studies,[8,43] the 12 patients with lung abscesses reported had no clear data regarding complications, and hence, were excluded from the total complication rate

Indication

The main indication for PTD is when medical therapy fails, and it is required as a substitute for thoracotomy and lobectomy. PTD is particularly useful when the risks of surgery are prohibitive, but it may also be considered in patients who are actually clinically fit for surgery, as has been suggested by Yellin and colleagues.[18] These authors studied patients with primary pyogenic lung abscess during the years 1972 and 1982. Seven of these patients (14%) did not respond to conservative medical therapy and were candidates for lobectomy. All were treated with PTD and had complete recovery with no complications or relapse after a follow-up period of 2–5 years. Complete recovery following external drainage questions whether lobectomy is needed at all, especially if it involves resection of functional lung parenchyma and imposes much greater trauma than PTD. Indeed, several studies have reported that complications were greater after surgery than after tube drainage, despite the fact that patients treated with drainage were generally sicker, and hence, more liable to complications.[6,15,19-21] Postoperative mortality after surgery for lung abscess has been reported to range from 11 to 16%.[14,15] In contrast, the cumulative rate of mortality as a complication of a lung abscess treated with PTD was reported to be 4.8% in a previous review article.[22]

The size of the abscess itself is also a criterion indicating PTD, since patients with large abscesses are at a risk of aspiration of their own secretions. Surgical drainage of abscesses larger than 4–8 cm in diameter has been advocated by several authors.[19,20,23] In one study where the mortality of patients with lung abscesses was reviewed, 22% of 33 fatalities were attributed to aspiration of abscess contents.[9] More recently, larger abscesses were found to be associated with poor prognosis and increased morbidity, but not with increased mortality.[8] Accordingly, a more aggressive approach in treating such patients was recommended.

PTD is also indicated in debilitated patients having a cough that is poorly effective in achieving adequate spontaneous drainage.[23] This is particularly seen in an intensive care setting where patients are sedated, intubated, and mechanically ventilated.

Another possible indication for PTD is when the abscess cavity does not contain an air-fluid level and is homogeneous because some degree of tension may be present and sudden endobronchial decompression may be disastrous.[24] Moreover, avoiding massive hemoptysis may be a potential advantage of PTD. This may be achieved by providing prompt evacuation of the abscess contents, thereby stopping further growth of the cavity.[19] Although PTD is not usually recommended for the treatment of a lung abscess with massive hemoptysis, it may be considered for hemodynamically unstable patients not fit for lobectomy. This condition was described in one of the seven cases reported by Weissberg *et al*.,[12] and PTD was successful in treating both sepsis and massive hemoptysis.

Before considering PTD in the event of failed medical therapy, it is important to rule out bronchial obstruction and bronchogenic malignancy since these are indications for surgical resection and not PTD. This can be achieved by bronchoscopy, which should be performed before attempting PTD. In the current review, however, only one third of the 124 cases had undergone bronchoscopy prior to PTD. Yellin *et al*.[18] reported three cases of lung cancer presenting with lung abscess in which PTD failed and a lobectomy was performed. Nevertheless, PTD may have a palliative role by relieving sepsis in the presence of unresectable lung cancer. This point was noted by Lawrence

et al.,[25] who described three cases of lung abscesses associated with unresectable lung cancer that were successfully treated, from the sepsis point of view, by tube drainage.

Technique

Drainage catheter insertion is usually performed under local anesthesia using either fluoroscopic, ultrasonographic, or computed tomographic (CT) guidance to avoid the uninvolved part of the lung. Radiographic guidance also helps in assessing pleural involvement, detecting loculated cavities, and determining the optimal position of the catheter.[26] However, it has been reported that PTD can be performed safely as a bedside procedure without imaging aids.[18] The hypothesis was that after a few weeks of medical treatment, the diseased area adheres to the chest wall, minimizing the risk of intra-pleural spread, and hence, the need for imaging guidance.[18] Once the catheter is in place and the abscess evacuated, gentle irrigation with normal saline is performed until the retrieved fluid is clear.[23] The tube is then connected to an underwater seal employing a negative pressure[12,18] or direct suction.[23,24] Periodic irrigation using 5–15 ml of normal saline should be performed daily.[23,24,26] Such irrigation may facilitate and expedite drainage.[19,23,27] The role of intra-cavity fibrinolytic agents in shortening the duration of percutaneous drainage is unknown. In a prospective randomized study of patients with peritoneal, retroperitoneal, and parenchymal abscesses, Haaga and colleagues examined urokinase and saline as abscess cavity irrigants.[28] They concluded that although the remission rate was not different between the two groups, urokinase was effective in shortening the treatment time, and it improved the clinical course.[28] In addition, post-drainage contrast sinography may offer information on cavity closure,[25] although plain chest radiographs are normally sufficient for follow-up.[23]

There is a wide variation in the ideal size of the percutaneous tube to be used.[12,18,23,24,26] However, it is well established that a small tube of French size 10–14 can adequately and effectively drain pus.[23,24] In one report, a change in catheter from French size 7 to 10 was necessary in two patients to maintain adequate drainage.[24] Although the use of a large tube appears unnecessary since it may cause undesirable trauma to the lung,[23] it may still be indicated in patients with extremely tenacious and viscous material.[18,19]

Efficacy and Safety

Weissberg *et al*.[12] described seven patients with severe sepsis not suitable for surgery. Prompt clinical recovery post-PTD was reported in all patients with complete resolution of abscesses within 4–24 days without complications. Shim *et al*.[3] also reported the result of PTD in four patients with refractory lung abscesses; all patients defervesced promptly and all cavities closed over 6–12 weeks. The patients tolerated the tube drainage well and there were no side effects.[3]

Another advantage of PTD is rapid clinical and radiological improvements in pyogenic lung abscesses, and thus, the avoidance of potential complications associated with conservative and prolonged treatment. Van Sonnenberg *et al*.[23] reported a 100% cure rate in 19 unresponsive patients treated with CT-guided PTD. The average duration of drainage was 9.8 days, while hemothorax was reported in only one patient. Ha and colleagues reported complete abscess resolution in four of six patients treated with small catheters; the mean drainage duration was 15.5 days.[26] One of the remaining two patients showed a partial response and the other did not respond. The failure of PTD in the latter case was due to recurrent aspiration; no complications were related to the procedure itself.[26]

On the other hand, in one study, the incidence of secondary surgical resection after primary drainage was 11% in 295 patients.[19] This is close to twice the number seen among the 124 cases reviewed in this article, which was 6.5% (8/124); this indicates that PTD is becoming more effective, thus avoiding the need for more invasive procedures.

Although most studies demonstrated good results with PTD, it should be emphasized that the efficacy of this procedure is still being debated, and it is not always successful. Most recently, Yunus reported 19 cases with lung abscesses treated using CT-guided PTD.[29] The success rate was 79% and the complication rate, 60%. In a cohort study, Hirshberg and colleagues attempted PTD in 11 patients; the procedure was technically successful in eight patients only, and five of these patients died.[8] Factors that may lead to failure of PTD may include secondary lung abscess, co-morbid illnesses, virulent organisms, multiloculation, poor definition of the cavity, and a thickened wall cavity that may not collapse.[4,8]

Single percutaneous aspiration of abscess contents could also be therapeutically successful. In one study, after the failure of medical therapy, single percutaneous aspiration was performed in 10 patients.[30] Nine of these responded and recovered completely, while the remaining patient required percutaneous drainage.[30] In addition, percutaneous aspirate cultures were often diagnostic and informative, and hence, the treatment plan could be modified accordingly. Yang *et al*. described 10 patients (43%) whose antibiotic regimen was changed based on the results of percutaneous aspiration culture and sensitivity tests.[31] Seven out of 10 (70%) patients improved within 1–3 weeks with the new antibiotic coverage. It can therefore be concluded that aggressive interventional drainage can be of diagnostic as well as therapeutic value in managing lung abscesses.[31-34]

In summary, the overall success rate of PTD can reach 84% with a complication rate of 16% and associated mortality of 4% (which is much lower than that associated with surgery). This supports the efficacy and safety of PTD in the treatment of pyogenic lung abscesses.

Timing and Duration

The most suitable period for delay prior to PTD initiation remains unknown. However, refractory lung abscesses should not be left for too long without drainage.[12,23] A 10–14-day period of conservative medical therapy without clinical improvement has been suggested.[24] In cases of sepsis, deteriorating patient condition, or in conditions associated with a high mortality rate, the abscess should be drained without any delay.[8,12,20] Whether immediate PTD is indicated in the management of a large lung abscess without prior antibiotic therapy is unknown.

In one study, two patients with giant abscesses had successful drainage within 24 h of presentation with no complications, death, or recurrence.[19]

On the other hand, the optimum duration of tube drainage has also yet to be determined; the criteria for removal vary from one report to another.[3,24,26] A remarkable reduction of abscess size with cessation of purulent draining for at least 3 days as well as the absence of clinical signs of abscess, even before the abscess cavity is completely resolved, are reasonable criteria for tube drainage removal.[26]

Complications and Mortality

In this updated review, clogging of the catheter necessitating tube exchange has been identified as a common complication of PTD, and is probably related to the use of small tubes.[23,24] Pneumothorax, hemothorax, and hemoptysis are potential complications. We identified reports of six pneumothorax cases but only one hemothorax case.[23,24,29] These complications may be related to the use of a standard chest tube and might be avoided by using a smaller one.[24] On the other hand, avoiding the puncture of normal lung parenchyma would also prevent pneumothorax and hemothorax.[23,26] In cases where abscesses are completely surrounded by normal lung parenchyma and require drainage, endoscopic tube drainage is probably a more suitable therapy. Contamination of the pleural cavity during the insertion of the drainage tube can also lead to empyema and bronchopleural fistula. Mengoli *et al*. reviewed 184 patients and reported persistent bronchopleural fistula in 19 patients (8%). Using imaging techniques to assess possible pleural symphysis and to determine a skin site closest to the abscess wall may reduce the risk of empyema.[26] However, despite using CT-guided PTD, Yunus reported two cases of empyema and bronchopleural fistula that required surgical intervention.[29] Other complications reported included chest pain and increased intracranial pressure.[23,30]

The overall mortality rate in this review was 4% (5/124), which is close to the rate reported in the last decade.[22] In a similar report that reviewed the literature from 1950 to 1985, the mortality rate was 13% in 694 patients treated with PTD.[19] This difference in mortality rates may be due to recent developments in PTD techniques, such as the use of smaller tubes and the abandonment of general anesthesia and rib resection, using more advanced imaging techniques, new developments in antibiotic therapies, differences in the type of patient treated (e.g. patients with different co-morbid illnesses and severities of infection), and/or a difference in the number of cases reviewed.

Despite all the promising aspects of PTD, lobectomy still has a role in the management of lung abscess. It is required for a multiloculated, thick-walled or poorly defined lung abscess. It may also be indicated in cases of malignancy, bleeding, empyema, and massive tissue necrosis.[18]

Endoscopic Drainage

Once medical therapy fails, the first consideration is PTD, as mentioned above. However, ED is an alternative to percutaneous drainage in patients with coagulopathies, those who have a fairly central abscess (where a significant amount of lung tissue needs to be traversed), and if other anatomic structures impede access to the cavity. In addition, there is always a concern of soiling the pleural space with the abscess contents in the case of PTD.[23] Thus, selected patients may be candidates for this procedure, such as those whose airway leads to an abscess or those in whom an endobronchial obstruction prevents drainage.[35]

Data regarding the efficacy of ED of parenchymal abscess cavities are scanty. This procedure was first reported by Metras and Chapin in 1954.[13] Since 1975, four more reports have been published. Altogether, 49 cases of pyogenic lung abscess with nine failures of endoscopic intervention have been described to date.[35-38]

The procedure requires standard flexible bronchoscopy.[39] Under fluoroscopic control, a guidewire is introduced into the cavity through the working channel of a flexible bronchoscope. Selective bronchography may be performed first to identify the airway leading into the cavity. In such patients, the guidewire is directly introduced through the bronchography catheter. When the guidewire is confirmed to be in place, the catheter and bronchoscope are removed. A pigtail catheter, 90 cm long and of a size of at least 7 F, is then slipped over the wire into the cavity. The correct position is checked with the application of contrast medium through the pigtail catheter. The guidewire is then removed and the catheter is secured at the nose. The abscess cavity is flushed twice daily with normal saline. Flushing with gentamycin in normal saline solution once a day has also been reported.[35] At all other times, the catheter is open to gravity drainage.

Endobronchial drainage has also been reported with the use of a laser. Transbronchial pigtail catheter drainage was used in three patients with refractory lung abscesses.[40] The catheter was introduced endobronchially via a bronchoscopic procedure. Laser was used to perforate the abscess wall through the airway into the abscess in order to provide a pathway for catheter insertion. An improvement in clinical and radiological parameters was noted immediately after catheter placement. The catheters were extracted after 4–6 days, and all patients had a complete clinical recovery.[40]

Conclusion

In conclusion, PTD is a safe and effective method for treating lung abscesses, and it is probably the invasive treatment of choice in a medically complicated patient who has failed medical treatment. PTD may also be considered as an alternative to lobectomy, even in patients fit for surgery. However, it is worth remembering that the evidence available regarding the efficacy of PTD is of level 5, that is, evidence is derived from uncontrolled case series, emphasizing the need for randomized trials. An alternative procedure to PTD is ED, particularly in coagulopathic patients, those with airway obstructions, or those with fairly central abscesses.

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