Image-guided catheter drainage in loculated pleural space collections, effectiveness, and complications

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ABSTRACT

Introduction: Image-guided drainage is an established technique with a multitude of applications. The indications, techniques, and management of image-guided catheter drainage, however, continue to evolve. Image-guided drainage alone is sometimes sufficient for the treatment of a collection, but it can also act as an adjunct or temporizing measure before definitive surgical treatment. Drainage of a symptomatic collection is performed to drain pus from the cavity, working in conjunction with antibiotics. Infected collections accumulate antibiotics to a limited extent, which generally precludes effective treatment with antibiotics alone unless the collection is very small (1–3 cm). There are many indications for image-guided drainage in the chest, including pleural disease, lung parenchymal, pericardial, and mediastinal collections. Pleural collections represent a common clinical problem, for which image-guided drainage is recommended to reduce complications encountered as a result of blind drainage. Aim and Objective: To evaluate the efficacy and complications of ambulatory catheter drainage system for infective and loculated pleural collection.

Materials and Methods: The study was conducted in the department of radiodiagnosis and imaging, Sheri Kashmir Institute of Medical Sciences Srinagar 2016 to 2018. It was prospective in nature. All the patients were referred from in patient department as cases of clinically symptomatic pleural collections with image-based evidence of loculations or septations. All 30 patients referred for drainage were imaged using suitable imaging technique (USG or CT) to quantify and document presence of septations and loculations in pleural collections. Mean attenuation of pleural fluid, presence of internal echo’s and associated pleural thickening (>2 mm) was noted. Results: The overall success rate in our study was 77%, with recurrence in 10 % of patients and failure rate of 13 %. The outcome as per etiology was success rate of 100% in parapneumonic effusion, 70 % in TB, 50 % in malignancy and 100% in pleural collection after recent surgical intervention. The common procedure related complications noted in our study were hemothorax (3%), post procedural pain (23 %), pneumothorax (3%). Conclusion: Image guided percutaneous drainage of loculated pleural space collections is an effective and safe procedure.

KEY WORDS: Attenuation, empyema, loculations, percutaneous drainage, pigtail catheter

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INTRODUCTION

Image-guided drainage is an established technique with a multitude of applications. The indications, techniques, and management of image-guided catheter drainage, however, continue to evolve.[1] Image-guided drainage alone is sometimes sufficient for the treatment of a collection, but it can also act as an adjunct or temporizing measure before definitive surgical treatment.[2] Drainage of a symptomatic collection is performed to drain pus from the cavity, working in conjunction with antibiotics. Infected collections accumulate antibiotics to a limited extent, which generally precludes effective treatment with antibiotics alone unless the collection is very small (1–3 cm).[3]

There are many indications for image-guided drainage in the chest, including pleural disease, lung parenchymal, pericardial, and mediastinal collections. Pleural collections represent a common clinical problem, for which image-guided drainage is recommended to reduce complications encountered as a result of blind drainage.

There are few absolute contraindications to image-guided drainage, profound uncorrected coagulopathy, clinical instability, and lack of safe access to a collection.

Imaging methods
Selection of ultrasound or computed tomography (CT) for the guidance of drainage is influenced by several factors, including the location of the fluid collection and the benefits and complications of each imaging modality. For example, a simple paracentesis is best performed under ultrasound guidance. More complicated drainage procedures are best performed with CT guidance.

Catheter selection
Various catheters and introducing systems are available for percutaneous collection drainage; the choice depends mainly on operator preference. As with most interventional procedures, the clinician or radiologist must be familiar and comfortable with the system chosen. In general, thicker fluid is best drained with larger caliber catheters. A 10- to 14-Fr catheter provides adequate drainage for most collections. Smaller (8 Fr) catheters are adequate for less viscous collections. Catheters with retention devices, such as a locking loop, are frequently used to prevent catheter dislodgement.

Catheter insertion can be performed using the trocar or the Seldinger technique. After the drainage catheter is placed, the cavity is completely aspirated. Repeat images are obtained to determine the size of the residual cavity, the position of the drainage tube, and whether the entire collection communicates with the drainage tube.[4]

Complications due to placement of the pigtail catheters in the pleural cavity
The various complications include hemothorax, pneumothorax and injury to abdominable viscera. Other catheter-related complications include blockage, dislodgement, kinking, infection and disconnection.

We set out to to evaluate the efficacy and safety of image-guided percutaneous pigtail catheter drainage system for loculated pleural space collection.

MATERIAL AND METHODS

The study was conducted prospectively at the Department of Radiodiagnosis and Imaging, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, in collaboration with the Department of Internal Medicine and Cardiovascular Thoracic Surgery from 2016 to 2018. All the patients were referred by the general physician, general surgeon, pulmonary physician, or the CVTS surgeon from the inpatient department as cases of clinically symptomatic pleural collections with image-based evidence of loculations or septations.

All 30 patients referred for drainage were imaged using suitable imaging techniques (ultrasonography [USG] or CT) to quantize and document the presence of septations and loculations in pleural collections [Figures 1-3]. The mean attenuation of pleural fluid, presence of internal echos, and associated pleural thickening (>2 mm) was noted. Informed consent was taken from all patients or their attendants for the procedure. After all baseline preparation and suitable catheter choice, interventional procedure was carried out under suitable image guidance (USG, fluoroscopy, or CT) [Figure 4].

All procedures were done under local anesthesia. The insertion of catheters was done using the modified Seldinger technique. The catheters were removed as soon as the drainage was <25 mL per day for 3 consecutive days. Patients were followed daily during daily rounds and with chest X-ray and chest CT, whenever deemed necessary. The catheters were irrigated as and when needed. Patients were bought to the radiology department suite for USG examination and catheter repositioning or exchange if there is any problem with the catheter. In the end, the catheter was removed when catheter removal criteria were met and the size of the residual collection was noted.

The terms such as success, recurrence, and failure were defined as follows:

- Success: The disappearance of all clinical and laboratory findings related to pleural infections during follow-up of at least 3 months
- Failure: The persistence or exacerbations of clinical and/or laboratory findings related to pleural infection that eventually required surgery
- Recurrence: The reappearance of clinical and/or laboratory findings of pleural space infection on the same side following a temporary period of improvement after catheter removal.
Exclusion criteria
Patients who had clinical instability, coagulopathy or those who did not consent for the procedure were excluded from the study.

Statistical method
The recorded data were compiled and entered into a spreadsheet (Microsoft Excel). Continuous variables were summarized as mean, and categorical variables were expressed as frequencies and percentages. Graphically, the data were presented by bar diagrams and pie charts. The statistical analysis was performed by PASW version 18 software (Quarry’s Bay, Hong Kong) using Chi-square or Fisher’s exact tests when expected frequencies were small. Frequency test was used to assess positive and negative predictive values. Statistical significance was set at $P < 0.05$.

RESULTS
In our study, of total 30 patients, 17 (57%) were male, and 13 (43%) were female, with a mean age of 44 years. The maximum number of patients was between 40 and 60 years. As of etiology, of 30 patients, 12 had parapneumonic effusion, ten had tubercular effusion, six had malignant effusion, with two having loculated pleural effusion after the surgery. Out of 30 patients, 26 had mild effusion, three had moderate, and the only single patient was having massive effusion. Seventeen patients had right-sided effusion, whereas 13 patients had left-sided effusion. Out of 30 patients, ten had thick septations, eight had internal echos, ten had mean fluid attenuation of $>10$ HU, and seven had associated pleural thickening. CT guidance was used in 28 patients, USG alone was used in one patient, and fluoroscopy alone was used in one patient.

The average size of the catheter used was 10 Fr (range: 8–12 Fr). The average duration of the catheter in place was 6 days.

The overall success rate in our study was 77%, with recurrence in 10% of patients and failure rate of 13%. The outcome as per etiology was success rate of 100% in parapneumonic effusion, 70% in TB, 50% in malignancy,
and 100% in pleural collection after recent surgical intervention. Thirty percent of patients with tubercular effusion had failure of procedure, whereas in malignant effusion, the failure rate was 17% with 33% showing reaccumulation.

DISCUSSION

The merits of catheter drainage of abscesses and fluid collections in the abdomen are well known,\[5-11\] but the use of percutaneous catheter drainage (PCD) for pleural fluid collections received much less attention in the past. Van Sonnenberg et al.\[5\] and Gobien et al.\[12\] reported the successful treatment of patients with empyema and mediastinal collections, respectively, using image-guided PCD in the early 1980s.

PCD of pleural fluid collections using CT, sonographic, and fluoroscopic guidance offers several potential advantages over needle thoracentesis and chest tube drainage. Direct demonstration combined with the use of a small (18-gauge) needle, J-tip guidewire, and a smaller catheter (pigtail) provides safe and relatively easy access to fluid collections and avoids the complications of tube misplacement. The placement of a long segment of the catheter within the pleural space facilitates drainage, and catheter stability with PCD being particularly useful for draining loculated collections with difficult access. Small catheters also appear to be better tolerated by the patient than large chest tubes causing less discomfort. As far as procedural complications are concerned, the image-guided PCD is believed to cause a significant reduction in complications as compared to intercostal chest tube drainage (ICTD). Liu et al. in 2010 strongly suggested that USG-guided pigtail catheters isconsidered as the initial draining method for various pleural diseases, as it provides a safe and effective method for drainage.\[13\]

Effectiveness of pigtail drainage

The overall success rate in our study was 77%, with recurrence in 10% of patients and the failure rate of 13%. The outcome as per etiology was success rate of 100% in parapneumonic effusion, 70% in TB, 50% in malignancy, and 100% in the pleural collection after recent surgical intervention. Thirty percent of patients with tubercular effusion had failure of procedure, whereas in malignant effusion, the failure rate was 17% with 33% showing reaccumulation. As for overall success rate is concerned, our results are comparable to results of many internationally published research articles Bediwy et al.\[14\] who reported an overall success rate of 82.3%. The success rate in parapneumonic effusion and tubercular effusion was also comparable (80 vs. 100 and 83 vs. 70%, respectively). Moore et al. reported the success rate of 78% in empyema drainage (15 out of 19),\[15\] and Westcott\[16\] who reported a success rate of 91% in empyema thoracis with the use of PCD. Akhan et al. also reported a success rate of 92.5%, failure rate of 7.5%, and recurrence rate of 6.4%.\[17\]

In 2006, Jain et al. reported the success rate of 92% with the use of small-bore catheter in loculated pleural effusion,\[18\] whereas Lui et al. also reported a success rate of 72.2% in parapneumonic effusion/empyema.\[13\] Our results are also comparable with the results of Shankar et al., who reported successful drainage in 80 among 103 patients by placing small (<14 F) drainage catheter under US or CT guidance.\[19\]

Factors governing success rate

Four imaging characteristics were evaluated in our study governing the success of drainage of pleural space collection, namely the presence of thick septations, internal echo’s, mean CT attenuation of >10 HU, and pleural thickening (Table 1).

The absence of thick septations with mean CT attenuation of <10 HU had strong negative predictive value for the failure of drainage as compared to the presence of internal echos (95% vs. 81.5%). The pleural thickening had negative predictive value of 86.9% for failure. The presence of thick septation (P = 0.002), mean attenuation of >10 HU for failure (P = 0.002) and presence of pleural thickening (P = 0.03 were significantly associated with failure of the procedure. There was no significant relationship of the presence of internal echos and failure of the procedure.

Akhan et al. also reported a similar negative predictive value for failure, 94 and 96% for loculations and septations, respectively.\[17\] Huang et al. also demonstrated that loculation and pleural effusion leukocyte count were the only independent predicting factors related to the failure of tube thoracostomy drainage.\[20\]

After a thorough analysis of imaging characteristics of the pleural space collections and final outcome, a scoring system can be formulated with regard to predicting failure of PCD. Greater weightage should be given to presence of thick septations, mean CT attenuation of >10 HU, and associated pleural thickening than the presence of internal echos. However, a well-dedicated study with a large sample size needs to be conducted for that.

Complication profile

The complications in the form of hemothorax, pneumothorax, injury to solid organs, catheter-related complications in terms of displacement/dislodgement and blockage, and need of repositioning of catheter were also evaluated during the course of our study.

Procedure-related complications

The common procedure-related complications noted in our study were hemothorax (3%), postprocedural pain (23%), and pneumothorax (3%). The pneumothoraces were minimal that resolved of its own.

On reviewing the literature pigtail catheter drainage is usually safe, our complication profile is in full agreement with many of the internationally published studies.
Liu et al. reviewed 276 patients who underwent pigtail catheter under USG guidance for the pleural effusion of various etiologies and reported hemothorax in 0.3% of patients. Akhan et al. conducted pigtail drainage of infected pleural effusion in 93 patients and reported pneumothorax in 2.2%. In 2006, Jain et al. studied the efficacy and complications of percutaneous small-bore pigtail catheters for tube thoracostomy and reported small pneumothoraces in 20% and chest pain at tube thoracostomy site requiring analgesics in 60%. The author concluded that small-bore pigtail catheters are safe, comfortable, cost-effective, and have few complications, especially in loculated pleural effusions.

Catheter-related complications
The common catheter-related complications in our study include kinking of catheter (3%), dislodgement of catheter (3%), and blockage of catheter (6%) [Table 2]. Our catheter blockage rate was comparable with the study done by Bediwy et al. in 2011 (3.92% vs. 6.6%). Jain et al. in 2011 reported the blockade of catheter in 8% of patients who had undergone percutaneous small-bore pigtail catheter for tube thoracostomy. Warren et al. used pigtail catheter in 202 patients with symptomatic malignant pleural effusions on an outpatient basis, and the incidence of blockage was 4.8%. Liu et al. reviewed 276 patients, who underwent pigtail catheter under USG guidance for the pleural effusion of various etiologies and reported dislodgement in 1.2% of patients. Akhan et al. reported the kinking of catheter in 1.1% and occlusion of catheter in 3.2% of patients, among 93 patients who underwent pigtail drainage of infected pleural effusion.

CONCLUSION
- Preprocedural imaging characteristics in the form of thick septations, internal echoes, and mean CT attenuation value can help us in predicting outcome after PCD of loculated pleural effusion.
- Image-guided percutaneous drainage of loculated pleural space collections is effective and safe procedure
- We recommended its use, especially in parapneumonic effusion

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PROFORMA

Name: MRD:

Residence: Ph No.:

Age/Sex:

Date of admission:

Date of discharge:

Diagnosis:

Initial imaging studies (X‑Ray, USG, CT scan):

Intervention done:

Procedure:

Intra procedural complication (if any):

Spot drainage (amount):

Follow-up:

Drainage after 24 hours:

48. hours:

72. hours:

Whether streptokinase instilled (if yes then dose and details):

Interval check X-ray:

Any postprocedural complication:

Residual collection (if any):

Conclusion: