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Original Research Article

Comparative analysis of pigtail catheter versus intercostal tube drainage for pleural effusion: a tertiary centre study

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ABSTRACT

Background: This study was conducted to compare the effectiveness and complications between chest tube and pigtail catheter thoracostomy for drainage of pleural effusion.
Methods: We retrospectively reviewed the medical records of 60 patients with pleural effusion during the period of January 2021 to June 2022. We collected data on fluid drainage, complications, and hospital stays among participants.
Results: The difference between various parameters (protein, sugar, pH, and culture positive) measured on drained pleural fluid was statistically nonsignificant (p>0.5). A total of 4 (13.3%) and 2 (6.7%) cases were not drained in the intercoastal tube and pigtail catheter groups, respectively (p=0.389). Further, a total of 14 (46.7%) and 6 (20%) participants in the intercoastal tube and pigtail catheter groups respectively complained of wound pain (p=0.028). Lastly, the incidence of complications among the participants in the intercoastal tube and pigtail catheter groups was 30% and 16.7% (p=0.222). The most common complications in both groups were pneumothorax. Moreover, a total of 10% of participants in the intercoastal tube group experienced kinking or dislodgment of the tube. The duration of hospital stay was significantly shorter among participants with pigtail catheters.
Conclusions: The pigtail catheter was equally efficacious as an intercoastal tube, but it caused lower pain, shorten the duration of hospital stay, and reduced the complications among participants.

Keywords: CTVS, Drainage, General surgery, Intercoastal, Pigtail, Pleural effusion

INTRODUCTION

The removal of accumulated fluids from the body is a procedure that is frequently required in a wide variety of medical subspecialties. The removal of intra-abdominal collections (such as bile secretions, pancreatic secretions, bloody collection, urine, or air), pleural collections (such as pleural effusion, empyema, or pneumothorax), wound fluids, or abscesses requires the use of drains.[1,2] Drains are also necessary to remove abscesses. A great number of drains have been designed, categorized, and put into use. Drains that are placed in the chest are among the most common types of drains used by thoracic surgeons, anesthesiologists, and physicians who specialize in critical care. Pleural effusion, empyema, hemothorax, pneumothorax, pleurodesis, and pleural effusion are some of the indications for chest drains.[1-6] Pleural effusion drains may also be used post-surgically in certain operations. Both chest tube drainage and pigtail catheter drainage are frequently used in the process of pleural collection drainage. Chest tube drainage is the more traditional method. Every one of them comes with its own set of signals, benefits, and drawbacks.

Large-bore chest tubes were traditionally used to drain pleural effusion, a complication that can be caused by pneumonia, TB, and a wide variety of other inflammatory and infectious disorders. Before the chest tube can be placed into the pleural space, however, this treatment demands that an incision be made in the patient's skin and that a blunt dissection be performed on the intercostal muscle. This invasive operation is consequently linked to

the possibility of consequences, including hemothorax, pneumothorax, organ perforation, diaphragm laceration, empyema, pulmonary oedema, and Horner's syndrome. These complications can arise as a direct result of the procedure. In recent years, the utilization of a pigtail catheter, which is characterized by its flexibility and small bore, in conjunction with a Seldinger technique has emerged as a viable alternative for thoracostomy and pleural drainage. Because this is a less invasive operation, it results in less discomfort, a smaller scar both during and after the placements, and maybe fewer issues that are directly related to the procedure itself.

Therefore, the purpose of the current study was to evaluate and contrast the efficacy, safety, and complication rates of thoracostomy and pleural drainage using pigtail catheters against intercostal chest tubes in patients with pleural effusion who had been advised to have either procedure.

METHODS

Study design

This was a hospital-based, retrospective cohort study after approval was obtained from the Institutional Ethical Committee (LNMC&RC/Dean/2021/Ethics/264).

Study population

Patients aged more than 18 years of age and diagnosed with pleural effusion who underwent thoracostomy either using the chest tube or pigtail catheter were included in the study. The severity of the pleural effusion was assessed following the Light's classification.[2]

Study setting

Department of General Surgery, L. N. Medical College and JK Hospital, Bhopal.

Study duration

The study duration was 18 months from January 2021 to June 2022.

Sample size

The data from all patients diagnosed with pleural effusion who underwent thoracostomy during the period of study were included and analysed in the present study.

Exclusion criteria

Patients ascribed to empyema initially or who had been intubated with tracheal tubes were excluded from this study.

Following this, we included data from a total of 60 patients in the present study: 30 patients had an intercostal chest tube and 30 patients had pigtail catheters. The patients were given local site anesthesia, and the puncture site, usually in the midaxillary line of the fourth to fifth intercostal space, was well prepared using all aseptic precautions.

Procedure for chest tube insertion

The skin was dissected and a trocar-needle-tube combination set was inserted vertically into the rib cage to an assumed depth. When the pleural fluid was aspirated by syringe smoothly, the trocar was removed, and the chest tube was then pushed in over the needle to a premeasured distance or until resistance was met. The tube was then sutured and fixed on the skin as well as connected to a suction bottle by 10-cm H_2O negative pressure.

The procedure of pig tail catheter/drain insertion

A modified Seldinger technique was used. The pleural fluid was the first test aspirated by a small angiocatheter (16 gauge or 18 gauge, catheter over needle). The soft angiocatheter was then smoothly advanced to its full length, and the needle was removed. Thereupon, a soft-tip, J-shaped guidewire was inserted into the angiocatheter for an adequate length, usually >10 cm. Holding the guidewire on the chest wall, the angiocatheter was removed and a stiff dilator was then forwarded over the wire to enlarge the entry route. After the removal of the dilator, a pigtail catheter could be advanced freely over the guidewire into the pleural space. The guidewire was removed and the pigtail catheter was securely tapped or sutured on the chest wall and then connected to the suction bottle. The positions of the tubes or catheters were then confirmed by chest x-ray. The success of the intervention was defined as the evacuation of fluid smoothly (confirmed by chest x-ray) and no other intervention being required. Failure of intervention was defined as the persistence or increasing of fluid requiring an additional drainage tube or catheter or even a surgical thoracotomy.

Several variables were compared between these two groups with thoracostomy, including demographic data, bore size of chest tubes or pigtail catheters, drainage days, hospitalization days, complications, and any necessary rescue interventions. The possible thoracostomy-related complications, including pneumothorax, hemothorax, hepatic perforation, subcutaneous hematoma, and kinking or dislodgement of tubes or catheters, were identified and recorded.

The primary outcome was the success, safety, and complication rates among the participants who underwent thoracostomy using either intercostal drainage or pigtail catheter. We aimed to assess whether data supplied evidence for any significant difference between the success and complication rates among the two methods. All dependent and independent variables with necessary

explanations were first defined by the research team. All the data were collected in a paper-based data collection form. Thereafter, the data were coded and entered in Microsoft Excel. The coded data were imported into Stata 17.1 version for analysis. Data cleaning, including logical checks, outlier check, and variables engineering, were performed by experienced programmers. For the continuous data, the author calculated the mean, median, mode, and standard deviation.

Quantitative data confirming the properties of the normal distribution are presented as means±standard deviation. The data showing the properties of the non-normal distribution were presented as the median and the interquartile range. For discrete data, the author calculated and reported frequency, proportion, and percentage. We used logistic and linear regression for determining the association between the dependent variable (primary outcomes) and independent variables. A comparison of continuous variables with baseline values was analysed using a student's t-test in each group. Categorical variables were analysed using chi-square (χ^2) tests. A p value <0.05 was considered statistically significant.

RESULTS

Overall, the mean age of the participants was 56.3 years and there were 41.7% female participants in the study. The pleural effusion was almost equally common on the right and left side among participants and none of the patients had bilateral pleural effusion. Table 1 shows the distribution of sociodemographic characteristics of the participants in the two comparison groups. The mean age of the participants in the intercoastal tube group and pigtail group was 45.5 and 42.5 years, respectively (p=0.295). The mean weight of the participants in the intercoastal tube group and pigtail group was 68.5 and 64.5 kg, respectively (p=0.563).

Table 1: Descriptive characteristics of participants (n=60).

	Intercoastal drainage (n=30)	Pigtail catheter (n=30)	P value
Gender			
Male	18 (60.0)	17 (56.7)	0.762
Female	12 (40.0)	13 (43.3)	
Age (in years)			
<40	10 (33.3)	9 (30.0)	
40-69	16 (53.3)	17 (56.7)	
≥70	4 (13.3)	4 (13.3)	
Mean	45.5	42.5	0.295
Anatomical side			
Right	18	13	0.832
Left	12	17	
Weight	68.5	64.5	0.563

Table 2 shows the characteristics of the pleural fluid drained from the participants in the two comparative groups. The difference between various parameters measured on drained pleural fluid was statistically nonsignificant (p>0.5). A total of 7 (23.3%) and 4 (13.3%) cases were positive for bacteria on culture in the intercoastal tube and pigtail catheter groups, respectively (p=0.784).

Table 2: Characteristics of the pleural fluid (n=60).

Variables	Intercoastal drainage (n=30)	Pigtail catheter (n=30)	P value
WBC count*	14,150	15,350	0.465
pH*	6.78	7.2	0.784
WBC Count after drainage*	2200.50	1505.50	0.764
Protein* (g/dl)	3.8	4.1	0.673
Glucose* (mg/dl)	48.54	62.4	0.342
Culture positives	7 (23.3)	4 (13.3)	0.784

*- Mean value

Table 3: Outcome and complications among participants (n=60).

Variables	Intercoastal drainage (n=30)	Pigtail catheter (n=30)	P value
Size (Fr)	28	12	0.264
Drainage days*	5.5	4.5	0.017
Hospital days*	10.5	9.5	0.028
Failure to drain	4 (13.3)	2 (6.7)	0.389
Wound pain	14 (46.7)	6(20.0)	0.028
Complications	9 (30.0)	5(16.7)	0.222
Type of complications			
Pneumothorax	5 (16.7)	4 (13.3)	
Hemothorax	1 (3.3)	1 (3.3)	
Hepatic perforation	0	0	
Subcutaneous hematoma	0	0	
Kinking/dislodgement	3 (10.0)	0	

*-Mean value

Table 3 shows the outcome and the complication rate among the participants of the two comparative groups. A total of 4 (13.3%) and 2 (6.7%) cases were not drained in the intercoastal tube and pigtail catheter groups, respectively (p=0.389). Further, a total of 14 (46.7%) and 6 (20%) participants in the intercoastal tube and pigtail catheter groups respectively complained of wound pain (p=0.028). Lastly, the incidence of complications among the participants in the intercoastal tube and pigtail catheter groups was 30% and 16.7%, however, this difference was statistically insignificant (p=0.222). The most common complications in both groups were pneumothorax. Moreover, a total of 10% of participants in the intercoastal tube group experienced kinking or dislodgment of the tube.

DISCUSSION

A mortality rate of up to ten percent is associated with pleural effusion, which is frequently suggestive of the severity of the underlying lung disease. In cases with pleural effusion, the aspiration of fluid is less likely to be successful, hence the placement of a chest drain is nearly universally suggested. This is due to the fact that pleural effusion makes it more difficult to aspirate fluid.[7,8] Patients who are symptomatic and have modest effusions in an effort to avoid having a chest drain inserted are possibly the only patients for whom aspiration is clinically acceptable as a reason.[9,10] Over the past few decades, the large bore chest drain has been the therapy of choice. Nevertheless, the patient must remain sedentary for the majority of the day in order to comply with this modality, which exposes them to the possibility of experiencing a wide variety of difficulties.[11,12] The most significant difference between the ACCP guidelines published in the year 2001 and the BTS guidelines published in the year 2020 was a trend toward making the drainage of the plural fluid less invasive by using smaller catheters that are easier and faster to insert and that involve less patient discomfort. This change was brought about as a result of the BTS guidelines' publication in the year 2020. The findings of the several comparative studies that compared big and small-bore tube drains for the management of pleural effusion have varied and been in conflict with one another.[11-13] The current research aimed to determine whether or not small-bore catheters can successfully drain pleural effusion while also being safe and acceptable to the patient.

In the current study, we found that successful drainage of pleural effusion using pigtail catheter and ICT was 72.7% and 63.6%, respectively. However, this difference was not statistically significant (p>0.5), thus we cannot draw any conclusions from these findings. Vedam and Barnes.[14] conducted research that was quite similar to our own and compared the efficacy of ICT and pigtail catheters in the treatment of pleural effusion. They found that ICT was more successful but had a higher rate of complications. In 20 of the 31 (65%) patients who were first treated with ICT, successful pleural effusion clearance was obtained, while in 26 of the 36 (72%) patients who were treated with a pigtail catheter, successful resolution was achieved (p>0.5).

102 individuals were included in the study by Liu et al who had been diagnosed with pleural effusion.[15] Of these patients, 50 were first treated by pigtail drainage and 52 were treated with ICT insertion. There was not a statistically significant difference between the two groups, despite the fact that the success rate of the pigtail group was claimed to be significantly greater (70%) than that of the ICT group (28.8%). According to Tasi et al, the success rate for the pigtail group was 72.5%, while the success rate for the ICT group was 72.7% (p>0.5).[7] Benton and Benfield found that success rates for pleural effusion patients treated with pigtail catheter drainage (88%) and those treated with ICT drainage (80%) were statistically indistinguishable, indicating that the difference between the two groups was not statistically significant.[5] According to the findings of Chen et al, pigtail catheter drainage was successful in treating 118 individuals (or 70%), whereas the remaining 50 patients (30%) required additional care.[7]

In the current study, the frequency of various forms of complications following pleural effusion drainage in patients of both studied groups was 8 (36.4%), which was distributed mainly among the failed cases [all 7 failed cases had complications (100%)] where only one case out of 15 successful drainage cases had one complication (6.7%) with a statistically highly significant difference between the two groups. The complications that occurred the most frequently in the unsuccessful cases were tube displacement and sepsis (each at 42.9%), followed by surgical emphysema (14.2%), and the frequency of drainage complications occurred more frequently in unsuccessful cases of ICT (125%) than in unsuccessful cases of the pigtail group (80%). Benton and Benfield also reported data that were comparable with regard to the incidence rate of complications.[5] They reported that 5 cases (21%) with pigtail insertion were complicated with tube displacement and one case (5%) was complicated with surgical emphysema, while 2 cases (8%) with ICT insertion were complicated with tube displacement and 2 cases (8%) were complicated with surgical emphysema, and 7 cases (28%) were complicated with sepsis, with a statistically significant difference between the two groups. Pigtail insertion was more likely to result in complications than ICT insertion.

In terms of drainage duration, the current work reported a statistically significant reduction in drainage duration among patients who successfully drained using a pigtail catheter respectively (4.5 days) compared to ICT (5.5 days) (p=0.017). This reduction was seen among patients who had successful drainage. In the current investigation, the length of hospital stays among patients who successfully drained their fluid using a pigtail catheter was significantly shorter (seven days) than those who used ICT (nine days) (p=0.028). On the other hand, there was not a statistically significant difference between pigtail and ICT in terms of drainage time or length of hospital stay in cases where the procedure was unsuccessful. In a study that was very similar to ours, Liu et al reported a reduction in drainage days and length of hospital stay in both the pigtail and ICT groups.[15] However, the researchers found that the differences between the two groups were statistically insignificant: (5.2 days and 6.2 days of drainage respectively) and (7.5 days and 8.6 days of hospital stay respectively). In the study conducted by Vedam and Barnes, the ICT group had a mean length of hospital stay of 7 days, whereas the pigtail group had a mean length of stay of 5 days.[14] According to Tsai et al, there was not a statistically significant difference between the pigtail group and the ICT group in drainage days (94 days and 116 days respectively), and the length of hospital stays for patients with pigtail and ICT was 18, 12 days and 18, 15 days

respectively.[7] This was despite the fact that the pigtail group experienced a reduction in the number of drainage days. Benton and Benfield discovered a reduction in drainage days, however the difference between the pigtail group and the ICT group was statistically insignificant (3.32 days for the pigtail group and 4.72 days for the ICT group, respectively).[5] This observation was reported by Benton and Benfield.[5] People who were treated with pigtail had significantly shorter durations of drainage (3.3-1.9 versus 4.6-2.6 days) and hospital stays as compared to patients who were treated with ICT. 7% of patients had a complication during drainage.[16]

Limitations were the small number of pleural effusion cases that were enrolled in this study; the fact that pigtail catheters are relatively more expensive than ICT as a method of management of pleural effusion; the traditional general practitioner concept in treating pleural effusion by ICT drainage; the fact that the study assessed only pleural effusion and not other types of pneumothoraxes; and the fact that the study didn't answer the question of recurrence or drainage failure of pleural effusion after pigtail catheter drainage.

CONCLUSION

When treating the initial episode of pleural effusion, drainage with a pigtail catheter is almost as successful as drainage with an ICT catheter. In comparison to ICT, drainage of pleural effusion with a pigtail catheter takes less time and requires a shorter hospital stay. This procedure is safe and well tolerated by the patient. An increase in body mass index is linked to a failure in the drainage of pleural effusion, and obesity is recognized as a risk factor that has a high degree of specificity for pigtail catheter drainage failure.

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