

Comparative Study between the Use of Pigtail Catheters and Traditional Chest Tube Drain in Cases with Pneumothorax

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ABSTRACT

Background

Pneumothorax is a condition in which air or other gas is present in the pleural cavity. Mainstay of management of pneumothorax is to remove the air from the pleural space usually done by chest tube insertion. There is still uncertainty whether minimal invasive management with pigtail catheter is sufficient for the management of pneumothorax.

Objective

To find the effectiveness, safety, tolerability, efficacy of pigtail catheters and large bore chest tubes.

Method

Prospective comparative study was done in Dhulikhel Hospital between August 2019 till August 2021. Chest tube insertion used to be the only available treatment modality till December 2020 (15 months). Following January 2021 after obtaining ethical clearance for use of pigtail insertion for pneumothorax, this treatment modality was done (8 months).

Result

Among 76 patients, 52(68.4%) underwent a large bore chest tube and 24 (34.6%) pigtail catheter patients. Mean age of the patients was 48 years (SD 18.01). Duration of hospital stay and length of hospital stay was more in large bore catheters and less in pigtail catheters. Eight hours post tube placement of the expansion of the lungs was present in pigtail and was statistically significant. Pain killer used in pigtail catheters was limited to Non-steroidal anti-inflammatory drugs, for large bore catheter opioids were added and were statistically significant.

Conclusion

Pigtail catheter is nearly effective as compared to traditional wide bore catheters.

KEY WORDS

Large bore chest tube, Painkillers, Pigtail, Pleural space, Pneumothorax

INTRODUCTION

Pneumothorax is a condition in which air or other gas is present in the pleural cavity.¹ Management of pneumothorax is to remove the air from the pleural space, via pigtail catheters or using a large bore chest tube drainage.² British Thoracic Society Pleural Guidelines 2010 have recommended the insertion of small bore pigtail catheter of 10-16 Fr size should be placed at the top and front of the pleural cavity.³ American College of Chest Physician consensus conference recommended a larger intercostal tube of size 22-32 Fr.⁴ However, studies have reported that large-bore chest tubes could easily cause injury to the chest wall and the adjacent organs.³ It was also reported that pain, intrapleural infection, wound infection, drain-related visceral injury, and drain blockage are the most common complications caused by large-bore chest drain insertion.³ Similarly, pigtail catheters can lead to inadequate drainage of the air inside the pleural cavity and also may lead to clogging, kinking and obstruction.⁵ The evolution of guidelines for the management of pneumothorax since 2003 have evolved and have tended towards less invasive ways of management with small catheters.⁶ However some studies have also suggested success rates, duration of drainage and complication reported varied in different techniques.⁷

We aim to conduct a study to find the effectiveness, safety, tolerability and also to obtain precise efficacy of pigtail catheters and large bore chest tube in management of Pneumothorax.

METHODS

This is a prospective comparative study conducted in Dhulikhel Hospital, Kathmandu University Hospital between August 2019 till August 2021. As per study done in our center proportion of pneumothorax case in thoracic surgical unit is 10% among which 40% belong to spontaneous pneumothorax.⁸ So, estimated proportion of spontaneous pneumothorax in Dhulikhel Hospital is 4%, thus sample size calculated is 76 ($4pq/d^2$). All the cases who came with spontaneous pneumothorax who are above 18 years of age were included for the study during the time frame using census sampling. And all patients who had traumatic pneumothorax associated with hemothorax pyothorax, and patient unable to provide or rate pain assessment and who did not provided consent were excluded from the study.

Chest tube insertion used to be the only available treatment modality till December 2020 (15 months). Following January 2021 after obtaining ethical clearance for use of pigtail insertion for pneumothorax, this treatment modality was done (8 months). Patients diagnosed with pneumothorax with size more than 2 cm between the lung margin and chest wall at the level of hilum on plain

PA chest X-ray without any exclusion criteria were included in the study. Pneumothorax patients with circulatory and respiratory distress (tension pneumothorax) irrespective of the size of pneumothorax, in the form of tachypnea, apprehension, cyanosis, hypotension and tachycardia were also included in the study. Patients not giving consent, pneumothorax associated with hemothorax or pyothorax, small size pneumothorax (less than 2 cm between the lung margin and chest wall at the level of hilum), traumatic pneumothorax were excluded in the study.

For wide bore chest tube insertion, chest tubes of size 28-32 Fr were inserted as per standard chest tube insertion protocol.⁹ For pigtail catheter insertion, pigtails of size 10-14 Fr were inserted under ultrasound guidance in standard protocol.¹⁰ Pictures of insertion of pigtail is shown in figure 1 and figure 2. Following insertion, lung expansion and correct position of catheter or tube was checked at 8 hours, 24 hours and 48 hours.

Before placement of the chest tube investigator who was not involved in the study obtained the baseline chest wall pain score using numerical rating scale (NRS).¹¹ After the procedure 1-2 hours was waited till the local anesthesia effect wore off. Then a physiotherapist who is not in research obtains a pain scale on a regular basis till the chest tube is removed. All the patients who underwent the procedure had Non-steroidal anti-inflammatory drugs (NSAIDs) as a primary medication for pain killers. Addition of pain medication was dependent upon pain scale, more the pain score increased and pain killers were shifted to higher levels. And even after use of NSAIDs and opioids did not decrease patients pain he or she was shifted to Epidural anesthesia.

In cases of persistent air leaks for more than 5 days or recurrent pneumothorax after clamping the chest tube or pigtail catheter, chemical pleurodesis using 50 ml 10% betadine was performed and repeated in 48 hours if needed. In case of further persistent pneumothorax or broncho pleural fistula, surgical exploration will be performed. Success of the procedure was considered if there is complete expansion of lung and discharge of the patient with above mentioned criteria and discharge with removal of catheter. Procedure failure was considered if second drainage was required post removal of catheters in hospital settings and also required surgical management.

Data was collected in a self-designed performa which will include relevant information regarding patient particulars (Age, Sex, BMI, Occuaptaion, Smoker) and to find the effectiveness. Complications such as surgical emphysema, sepsis, tube displacement, safety, tolerability were also noted. The data will be entered into SPSS Version 21 for analysis.

The authors and members of the research team do not have any conflict of interest. The study has been approved by the institutional review committee. Informed written

consent was taken from all the participants of the study before inclusion in the study.



Figure 1. Pigtail in situ for right sided pneumothorax.



Figure 2. Pigtail as seen in chest x-ray.

RESULTS

There were a total 76 patients who underwent intervention, among which 52 patients (68.4%) underwent chest tube insertion while 24 (34.6%) patients underwent pigtail insertion. Mean age of intervention was 48 years (SD 17.50) range between 18-80 years. Similarly mean age in male patients was 48.87 (SD 18.01) and in females was 44.14 (SD 15.11) with p-value was 0.36. BMI of the patients for Large bore chest tube placement was 21.32 and for Pigtail placement was 17.86 on statistical analysis p-value was less than 0.05. There were 62 male patients (81.6%) and 14 female patients (18.4%). Similarly, there were a total of 48 patients in the chest tube presented with shortness of breath and only 4 patients in Pigtail catheter, on statistical analysis it appeared highly significant. Right sided chest tube placement in the chest tube was 31 and on the left

side it was 10. Similarly, on Pigtail catheter there were 21 patients for right side placement with left side 14. Smokers were 26 in chest tube patients and 4 among pigtail patients and non-smokers were 26 in chest tube patients and 20 among pigtail patients, statistical analysis showed p-value less than 0.05 (Table 1).

Table 1. General Characteristics of Chest tube and Pigtail Insertion patients.

Parameters	Chest Tube (52)	Pigtail (24)	p-value
Age (years)	50.69	42.17	<0.05
BMI (m/cm ²)	21.32	17.86	<0.05
Gender			
Male	44	18	0.24
Female	8	6	
Shortness of Breath			
Yes	48	4	<0.05
No	14	10	
Site			
Right	31	21	0.113
Left	10	14	
Smoking			
Yes	26	4	<0.05
No	26	20	

In outcome parameters, duration of tube insertion in chest tube was 3.94 days with pigtail 3.38 days which was statistically significant. Similarly, length of stay in hospital was 4.92 days for chest tube and for pigtail it was 4.58 for which p-value came 0.33. Expansion of pneumothorax within 8 hours was present among six patients in chest tube and among 16 patients in pigtail patients and p-value came highly significant. After 24 hours' expansion of the chest tube present in 38 patients and in pigtail 22 patients had complete expansion of pneumothorax however it was statistically not significant. After 48 hours' pneumothorax was expanded in 48 patients in chest tube patients however four patients did not result in expansion and in pigtail 22 patients had expansion of pneumothorax and two patients did not have expansion and p-value in statistical analysis came 0.92. Surgical emphysema was present among four patients in chest tube patients and there was no surgical emphysema post-procedure among pigtail patients, and statistically it was not significant. Similarly, chest tube displacement was present among four patients in chest tube placement and none in pigtail patients. Secondary infections were seen among two patients in chest tube patients and none in pigtail kept patients. Similarly, pleurodesis was required in 10 patients among chest tube patients and one patient in pigtail placed patients, in statistical analysis it came with a significant p-value 0.08. Negative suction was required in eight patients in chest tube patients and two patients for pigtail patients which came statistically insignificant. Similarly, in pain management NSAIDs were required among 12 and NSAIDs + Opioids among 36 patients and four patients required in

four patients in chest tube patients and 24 patients had NSAIDs only in pigtail patients in statistical analysis p-value came significant (<0.01) (Table 2).

Table 2. Details of Outcome in Two Groups

Parameters	Chest tube (52)	Pig tail (24)	P value
Duration of tube insertion (Days)	3.94	3.38	0.07
Length of hospital stay (Days)	4.92	4.58	0.33
Expansion at 8 hours			
Yes	6	16	<0.01
No	46	8	
Expansion at 24 hours			
Yes	38	22	0.06
No	14	2	
Expansion at 48 hours			
Yes	48	22	0.92
No	4	2	
Persistent pneumothorax			
Yes	4	2	0.92
No	48	22	
Surgical emphysema post procedure			
Yes	4	0	0.16
No	48	24	
Tube displacement requiring manipulation			
Yes	4	0	0.16
No	48	24	
Secondary infection			
Yes	2	0	0.33
No	50	24	
Need of chemical pleurodesis			
Yes	10	1	0.08
No	42	23	
Need of surgical procedure			
Yes	2	1	0.68
No	50	23	
Negative suction requirement			
Yes	8	2	0.39
No	44	22	
Pain management			
NSAIDs Only	12	24	<0.01
Opioids+NSAIDS	36	0	
Epidural+NSAIDS	4	0	

DISCUSSION

Pneumothorax is a common thoracic ailment requiring prompt intervention for successful treatment of the condition. In 2001, ACCP conference consensus recommended the use of wide bore chest tube for the management of pneumothorax, similarly in 2010 BTS, has changed the guidelines for minimal invasive management for pneumothorax.^{4,12}

Multiple studies have been done in many centers of the world to determine which is better as a line of management of pneumothorax. So, in our study we try to compare both pigtail catheter and wide bore chest tube catheter for the management of pneumothorax and its outcome to determine which has greater efficacy for the management of pneumothorax.

In our study, BMI among patients who underwent pigtail catheters was 17.86 and for wide bore chest tube placement was 21.32 which was also statistically significant, with age group higher in wide bore chest tube with 50.69 and for pigtail catheters 42.17 which was also statistically significant. Shortness of breath was more in patients in which chest tube was placed compared to the pigtail insertion group. Due to the start of government insurance in recent times, the health seeking behavior might have changed. Thus patients in earlier stages and without shortness of breath might have come more in recent times.

In a study done in 30 patients by Paincone in 2000 in Italy, efficacy of small bore catheter was compared with wide bore catheter in terms of efficacy, tolerability, days of hospital stay, extubation days, cost to patients and recurrence of pneumothorax.¹³ The study suggested both methods equally good for management of pneumothorax.¹³ Similarly Liu et al. in 2003 had done a study to see the efficacies of both the pigtail and chest tube for pneumothorax.¹⁴ The study suggested pigtail as less traumatic, well tolerated and has less ambulatory limitation.¹⁴ A study done by Vedam and Barnes in 2003 also concluded that both the procedure are equally effective for the management of the pneumothorax.¹⁵ There was however higher prevalence of combined complications and recurrences with the use of the small bore chest tube (42%) than with the large bore chest tube (16%).¹⁵ In a similar study done in 2009 by Benton and Benfield, efficacy of pigtail catheter is greater than that of large bore chest tube catheter in the management of pneumothorax.¹⁶

In our study, there was no statistical difference among pigtail and wide bore catheters in terms of length of hospital stay, however average stay in the hospital for pigtail catheters was shorter for pigtail catheters compared to wide bore chest tube catheters. Similarly in a study done among 22 patients by Hussein et al. in 2017 it has suggested, duration of hospital stay for pigtail catheters patients are shorter compared to patients who underwent wide bore chest tube placement.¹⁷ Persistent pneumothorax was present among only 2 out of 22 cases in pigtail patients whereas in the wide bore chest tube there were 4 patients out of 52 patients who had persistent pneumothorax post procedure on statistical analysis it also showed no significance. Similarly, lung expansion at 8 hours post intervention was better in the pigtail catheter group compared to the wide bore chest tube group which was statistically significant. Lung expansion at 48 hours post intervention was similar in both the groups. A possible reason for the early expansion

in case of pigtail catheter can be less procedure associated with pneumothorax due to less tissue damage.¹⁸ In a study done by Hussein et al. in 2017, among 22 patients the effectiveness of pigtail catheter and wide bore chest tube after 48 hours follow up with plain chest X-ray had no statistical significant differences.¹⁷

Post procedure complications such as secondary infection were present among two patients in large chest tube patients and none among pigtail catheters patients and there were no any statistically significant differences. As in a similar study done by Lin et al. in 2011 had also similar findings with no any statistical significance.¹⁹ Similarly, chemical pleurodesis was required among 10 out of 52 patients in larger bore chest tube placement and 2 patients among 24 had undergone chemical pleurodesis, on statistical analysis it p-value was significant. In a study done by Berger, it has been suggested that pleurodesis was required for pneumothorax post tube placement no matter small bore chest tube or wide bore chest tube following pneumothorax.²⁰

Use of painkillers among pigtail catheter and wide bore catheter had a significant difference as only NSAIDs was used among pigtail catheter patients which was enough for the patients to tolerate the procedure however for wide bore chest tube patients most of the patients requires combination of NSAIDs and Opioids and some required both epidural and NSAID. Thus a pigtail catheter is more

tolerable and comfortable to patients compared to wide bore catheters. The most reasonable for the use of less painkillers among pigtail catheters may be because there is less tissue damage while inserting pigtail in comparison to wide bore chest tubes. However, a study done in 2014 by Kulvatunyo et al. among 40 showed no difference in the use of painkillers post pigtail catheter placement and wide bore chest tube placement.¹⁰

The limitation of our study was that small number of patients were enrolled in the study, cost of the pigtail is slightly more than that of large bore chest tube, we only did study in pneumothorax cases so we were not able to compare pigtail and wide bore catheters in other pathology. In conclusion both pigtail catheter and wide bore chest tube catheter are effective in management of pneumothorax, however in use of pigtail catheter patients had less pain. The study also suggested painkiller use and hospital stay and other complications for pigtail catheter was much less compared to large bore catheters.

CONCLUSION

Pigtail catheters are nearly as effective as wide bore catheters. It offers more tolerability, safety and hospital stay, use of painkillers and other complications were much less compared to wide bore chest tube catheters.

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