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ORIGINAL ARTICLE

Retrospective Study

Closed thoracic drainage in elderly patients with chronic obstructive pulmonary disease complicated with spontaneous pneumothorax: A retrospective study

Wei Wang, Dong-Ning Zhu, Shan-Shan Shao, Jun Bao

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Abstract

BACKGROUND

Chronic obstructive pulmonary disease (COPD) combined with spontaneous pneumothorax, is characterized by significant decline in lung function, and even cause cardiopulmonary failure and hypoxia.

AIM

To evaluate the clinical effectiveness of central venous catheters and indwelling pleural catheters (IPC) in managing closed thoracic drainage in patients diagnosed with COPD with concomitant by spontaneous pneumothorax.

METHODS

Retrospective analysis was conducted on the clinical information of 60 elderly patients with COPD complicated by spontaneous pneumothorax admitted to the Shexian Branch of the second affiliated hospital of Zhejiang university school of medicine between March 2020 and March 2023. The clinical efficacy, complications, hospitalization duration, and costs were compared between patients with an indwelling thoracic catheter and those with a central venous catheter. Univariate logistic regression was used to analyze the causes of catheter displacement.

RESULTS

According to our findings, there were significant differences in the IPC group's clinical efficacy, catheter operation time, and lung recruitment time ($P < 0.05$). Comparing the complications after catheter treatment between the two groups revealed statistically significant variations in the incidence of postoperative analgesics, catheter abscission, catheter blockage, and subcutaneous emphysema in the IPC group ($P < 0.05$). Univariate analysis demonstrated significant differences between patients with and without catheter dislodgement regarding

duty nurse's working years (less than three), Acute Physiology and Chronic Health Evaluation II (APACHE II) scores (less than 15), lack of catheter suture fixation, and the proportion of catheters not fixed twice ($P < 0.05$).

CONCLUSION

Our results demonstrated that when treating elderly COPD patients with spontaneous pneumothorax, indwelling thoracic catheters are more effective than the central venous catheter group. Patients' catheter shedding is influenced by the primary nurse's working years, APACHE II scores, and catheter fixation technique.

Key Words: Indwelling thoracic catheter; Central venous catheter; Chronic obstructive pulmonary disease; Pneumothorax; Catheter detached

Core Tip: To evaluate the clinical effectiveness of central venous catheters and indwelling pleural catheters in managing closed thoracic drainage in patients diagnosed with chronic obstructive pulmonary disease with concomitant by spontaneous pneumothorax.

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INTRODUCTION

The blood oxygen levels decrease, lung volume expands, airway wall membrane deteriorates, and pleural effusion escalates in chronic obstructive pulmonary disease (COPD) accompanied by spontaneous pneumothorax[1,2]. The clinical presentation often includes symptoms such as cough, chest tightness, chest pain, and wheezing. This condition can be easily mistaken for an acute exacerbation of COPD. Without prompt intervention, respiratory failure can intensify, significantly heightening the risk of mortality [1,3,4].

Spontaneous pneumothorax, when not due to trauma or other external causes, is characterized by the accumulation of air in the pleural cavity. This accumulation arises from the sudden rupture of lung tissue and visceral pleura, allowing gas to infiltrate the pleural space[5]. Common precipitating events include sudden physical exertion, forceful coughing, diarrhea, sneezing, and even laughter, all of which can cause a significant increase in bronchial pressure[6]. Immediate thoracic puncture and decompression are crucial for managing spontaneous pneumothorax. To expedite lung re-expansion and forestall pleural adhesion, closed thoracic drainage of either pleural fluid or air is commonly executed in COPD patients with spontaneous pneumothorax, using indwelling thoracic catheters or central venous catheters (CVC) [7]. However, during the clinical procedure, the closed thoracic drainage catheter often becomes dislodged, necessitating additional punctures that increase patient discomfort, medical expenses, and the risk of infection[8,9]. This recurrent dislodgement of the catheter during the clinical procedure creates a need for further punctures, thereby exacerbating the patient's pain, associated costs, and infection risk[10].

In this research, we undertook a retrospective analysis of clinical data from elderly patients with COPD compounded by spontaneous pneumothorax. We compared the clinical outcomes, complications, and hospital expenses between those equipped with indwelling thoracic catheters and those with CVC. Moreover, we probed into the underlying causes of catheter displacement. Our objective is to furnish critical clinical insights that can refine nursing care for elderly COPD patients contending with spontaneous pneumothorax.

MATERIALS AND METHODS

General materials

From March 2020 to March 2023, 60 patients with COPD complicated by spontaneous pneumothorax who had closed thoracic drainage at Shexian People's Hospital were chosen. The Ethics Committee of Shexian People's Hospital gave its approval to this project.

Inclusion criteria

(1) Patients over the age of 50; (2) Confirmed cases of COPD fulfill the diagnostic standards outlined in the COPD Treatment Guidelines; (3) An X-ray examination revealed the patient had a spontaneous pneumothorax; (4) Pneumothorax was a first-time occurrence in every patient; and (5) Complete patient clinical information.

Exclusion criteria

(1) Patients with substantial heart, liver, kidney, and other organ damage; (2) Patients with a history of pneumothorax and mental disorders; (3) Patients with insufficient clinical and statistical data; and (4) Transferring to other hospital for treatment midway.

Methods

A total of 60 patients were included in the study, segmented into two groups based on the type of closed thoracic drainage catheter they received: the indwelling pleural catheters (IPC) group (n = 42) and the CVC group (n = 18). In the CVC group, a central venous catheter with a 2.1 mm diameter was utilized for closed thoracic drainage. Conversely, the IPC group was equipped with a 12th-size disposable indwelling thoracic drainage catheter boasting a 5.3 mm diameter. We documented patients' foundational data, encompassing gender, age, and body mass index (BMI). Complications registered included the usage of analgesics, catheter obstructions, dislodgements, subcutaneous emphysema, lung infections, and incision infections. We also meticulously recorded metrics such as the duration of catheterization, lung recruitment time, catheter lifespan, years of experience of the attending nurse (3 years in this context), Acute Physiology and Chronic Health Evaluation II (APACHE II) score, hospital stay duration, and associated hospitalization expenses, among other pertinent data for our retrospective analysis.

Evaluation of efficacy

(1) Evaluation as effective: Chest tightness was alleviated or eliminated, and chest imaging revealed all lung tissue recruitment; and (2) Evaluation as ineffective: The patient's symptoms did not improve after two weeks of catheterization, and chest imaging examination revealed no lung tissue recruitment or disease progression. Effective rate is equal to 100% effective/total instances.

Statistical techniques

SPSS 25.0 was used to statistically analyze the collected data. Utilizing the Chi-square test or continuously corrected chi-square test, statistical results were reported as a percentage (n/%). The mean and standard deviation were used to express measurement data. It employed an independent sample t test. The difference is regarded as statistically significant when $P < 0.05$.

RESULTS

Comparison of basic information of IPC group and CVC group

The gender, age, and BMI of 60 patients in the two groups are compared in Table 1. With an average age of 69.81 ± 6.69 years, 37 of them were male (61.67%), while 23 of them were female (38.13%), with an average age of 71.06 ± 7.7 years. Four of the patients were very underweight, 11 were overweight, and 41 had BMIs that were within the normal range. According to Table 1, there was no discernible difference between the IPC group and CVC group in terms of gender, age, or BMI composition ($P > 0.05$).

Comparison of clinical effects between IPC group and CVC group

In this study, 42 participants received IPC and 18 patients received CVC in the trial of 60 patients with COPD and spontaneous pneumothorax. We collected data on clinical efficacy metrics such as lung recruitment time, catheter operation time, catheter survival time, duration of patient hospitalization, and associated costs (Table 2). A comparative analysis of the two catheter types was performed. The findings revealed that the IPC group had significantly shorter catheter operation times (12.12 ± 1.09 min) compared to the CVC group (13.00 ± 1.53 min). Similarly, the pulmonary recruitment time was notably shorter in the IPC group (1.52 ± 0.27 d) than in the CVC group (2.92 ± 0.73 d), with both differences being statistically significant at $P < 0.05$. Furthermore, the IPC group exhibited a higher effectiveness rate of 95.2% in contrast to the CVC group's 72.2%, a statistically significant difference with $P < 0.05$.

Comparison of catheterization complications between IPC group and CVC group

When evaluating post-catheter therapy complications between the two groups (Table 3), the IPC group exhibited a higher rate of postoperative analgesic usage at 14.2%, compared to the CVC group's 5.5%. Conversely, the CVC group recorded higher incidences of subcutaneous emphysema (33.3% *vs.* 7.1%), catheter obstruction (36.3% *vs.* 7.1%), and catheter prolapse (38.8% *vs.* 4.7%). These differences were statistically significant with $P < 0.05$. However, there was no significant difference in infection rates between the two groups.

Univariate analysis of patients with catheter prolapse

Depending on whether catheter prolapse occurred, the 60 study participants were split into CP and nCP groups (Table 4). It was found that the nCP group, the working life of the responsible nurse was less than three years (43.18% *vs.* 62.5%), the APACHE II score was less than 15 points (25% *vs.* 37.5%), the catheter was not fixed with suture (48.18% *vs.* 68.75%), and the frequency of the catheter not fixed twice (40.9% *vs.* 56.25%) was lower than that in the CP group, $P < 0.05$, the difference was statistically significant.

Table 1 Comparison of basic information of indwelling pleural catheters group and central venous catheters group

Groups	Cases	Gender	Age (year)	BMI (kg/m²)			
		Male/female		< 18.5	18.5-24.9	25-29.9	> 30
IPC group	42	26/16	69.81 ± 7.79	3	29	6	4
CVC group	18	11/7	71.06 ± 7.70	1	12	5	0
t/χ^2		-0.57	-0.57	-0.167			
P value		0.954	0.571	0.867			

IPC: Indwelling pleural catheter; CVC: Central venous catheter; BMI: Body Mass Index.

Table 2 Comparison of clinical data between indwelling pleural catheters group and central venous catheters group, *n* (%)

Clinical data	IPC group (*n* = 42)	CVC group (*n* = 18)	t/χ^2	*P* value
Lung recruitment time (d)	1.52 ± 0.27	2.92 ± 0.73	-10.783	0[a]
Operating time (min)	12.12 ± 1.09	13.00 ± 1.53	-2.533	0.014[a]
Catheters survival life (d)	4.73 ± 0.65	4.8 ± 0.75	-0.415	0.679
Hospitalization time (d)	6.21 ± 0.68	6.06 ± 0.73	0.811	0.421
Hospitalization costs (thousand yuan)	46.29 ± 9.65	43.89 ± 10.26	0.865	0.39
Effective	40 (95.2)	13 (72.2)	4.44	0.035[a,b]

[a]Significant difference between groups.
[b]Continuous correction.
IPC: Indwelling pleural catheter; CVC: Central venous catheter.

Table 3 Comparison of catheterization complications between indwelling pleural

Complication	IPC group (*n* = 42)	CVC group (*n* = 18)	χ^2	*P* value
Use of analgesics	6 (14.2)	1 (5.5)	0.277	0.599[b]
Catheter occlusions	2 (4.7)	7 (38.8)	8.988	0.003[a,b]
Catheter prolapse	6 (7.1)	7 (36.3)	4.494	0.034[a]
Subcutaneous emphysema	3 (7.1)	6 (33.3)	4.880	0.027[a,b]
Pulmonary infection	1 (2.3)	1 (9.0)	0	1[b]
Incision infection	1 (2.3)	1 (9.0)	0	1[b]

[a]Significant difference between groups.
[b]Continuous correction.
IPC: Indwelling pleural catheter; CVC: Central venous catheter.

DISCUSSION

Our study revealed that elderly patients with COPD frequently demonstrate chronic inflammation of the small airways, heightened mucus gland secretion, ciliary dysfunction, degradation of the alveolar attachment structure, and fibrosis[11]. Moreover, these patients' airway lumens undergo compromised drainage, resulting from factors like excessive mucus secretion, decreased elasticity causing stenosis or deformation, recurrent reshaping of lung elastic fibers, and the onset of emphysema. As a result, there's a heightened occurrence of spontaneous pneumothorax in this elderly COPD population [12-14].

Spontaneous pneumothorax, which occurs in the absence of trauma or iatrogenic lung damage, is defined by an unexpected accumulation of air in the pleural space. It shows a bimodal age distribution, primarily appearing at ages 20 and 50[15]. While secondary spontaneous pneumothorax often manifests in older individuals with conditions such as COPD, interstitial lung disease, and other pulmonary disorders, primary spontaneous pneumothorax is more common in younger individuals who don't have an underlying lung disease[1,16,17]. Notably, in Japan, emphysema or COPD are

Table 4 Univariate analysis of patients with catheter prolapses, *n* (%)

Factors	CP group (*n* = 16)	nCP group (*n* = 44)	t/χ^2	*P* value
Gender			0.006	0.936
Male	10	27		
Female	6	17		
Age (year)	68.38 ± 9.493	70.84 ± 6.975	-1.096	0.278
BMI (kg/m^2)			1.899	0.618
< 18.5	1	3		
18.5-24.9	13	28		
25-29.9	2	9		
> 30	0	4		
Lung recruitment time (d)	2.30 ± 0.81	1.81 ± 0.75	2.226	0.06
Operating time (min)	12.69 ± 1.35	12.27 ± 1.26	1.103	0.274
Catheters survival life (d)	4.97 ± 0.81	4.68 ± 0.60	1.489	0.142
Hospitalization time (d)	6.13 ± 0.72	6.18 ± 0.69	-0.279	0.782
Hospitalization costs (thousand yuan)	47.25 ± 9.60	44.95 ± 9.93	0.799	0.428
Primary nurses working years ≤ 3	10 (62.5)	19 (43.18)	13.137	0[a]
APACHE-II score ≤ 15	6 (37.5)	11 (25)	9.201	0.02[a]
Not secured with sutures	11 (68.75)	19 (48.18)	13.611	0[a]
Not fixed twice	9 (56.25)	18 (40.90)	12.623	0[a]

[a]Significant difference between groups.
[b]Continuous correction.
IPC: Indwelling pleural catheter; CVC: Central venous catheter; APACHE-II: Acute Physiology and Chronic Health Evaluation II.

responsible for 60% to 80% of secondary spontaneous pneumothorax cases[12,18].

Elderly patients with spontaneous pneumothorax often exhibit poor cardiopulmonary function and rapid health deterioration, necessitating prompt and safe chest closure drainage to improve lung function and reduce mortality[19]. Currently, a variety of drainage tubes are utilized in clinical settings for chest closure drainage, including CVC, urine catheters, pig tail tubes, disposable silicone tubes (specifications and models: F12, F20, F24, F28, *etc.*), and chest puncture drainage tubes with inner cores[20,21]. The central venous catheter is widely used in clinical settings, primarily because of its comprehensive puncture package that includes a puncture needle, guidewire, cannula, blade, among other tools. Its appeal also lies in its narrow diameter, a soft and flexible catheter design, minimal hindrance to drainage efficiency, and user-friendliness[22,23].

While the IPC is relatively thick, ensuring smooth drainage and reduced likelihood of obstruction, the CVC is more delicate. Its lack of sufficient rigidity and a non-porous sidewall make it prone to obstructions, twists, distortions, or detachments, especially when folded[24,25]. Our study highlighted that shorter lung recruitment and catheter operation times led to better clinical outcomes. This advantage might be attributed to the IPC's capacity to stimulate the visceral pleura during lung recruitment, promote pleural fiber exudation, and assist in repairing pleural ruptures[26,27].

Elevated chest pressure or lung re-expansion can cause the catheter to bend and become obstructed, leading to lumen blockage, which in turn results in gas leaking along the side wall of the indwelling tube the development of emphysema [28,29]. Based on our findings, patients in the IPC group exhibited a reduced frequency of catheter prolapse, obstruction, and subcutaneous emphysema. This might be related to the increased space between the indwelling tube and the skin's soft tissue due to the skin-dilating effects of the CVC. Notably, the IPC group required a higher analgesic dosage compared to the CVC group. This could stem from factors like frailty, a weaker physical condition, and a diminished pain tolerance observed in some elderly COPD patients[30,31]. For many different reasons, the prolapse of chest closure drainage catheter is frequently found in clinical settings. In our study, there was a statistically significant correlation between catheter prolapse and the responsible nurse's years of service, APACHE II score, and catheter fixation technique.

During the clinical procedure, the chest closed drainage catheter was placed without suture puncture or fixation to minimize patient discomfort. However, due to the smooth nature of the catheter, patients were prone to experiencing slippage during daily activities[32]. According to this study, the risk of catheter prolapses increased with the ratio of unsecured catheters with sutures and unfixed catheters twice. Therefore, after inserting the drainage tube, sutures in clinical procedures must be fastened to prevent slippage[32]. Instead of utilizing medical tape for secondary fixation, just sterile dressing was used to cover the point where the catheter is attached to the skin. As a result, the catheter is simple to

remove when the patient perspires or scratches their skin. In order to prevent prolapse of the thoracic closed drainage catheter, on the basis of sterile transparent medical dressing, the drainage catheter was first glued into tic-tac-toe form with medical adhesive tape and then secured twice with adhesive tape at the catheter terminal junction[33-35].

The nursing care following the insertion of the chest closed drainage tube is crucial; however, in some cases, due to the limited clinical experience of certain responsible nurses, the patient's drainage tube may fall off as a result of inadequate psychological nursing, insufficient attention during shift handovers, and improper evaluation[31,36]. Our study revealed a positive correlation between the responsible nurse having less than 3 years of experience and the occurrence of catheter prolapse. This underscores the need to bolster the clinical training programs for nurses concerning drainage tube procedures. After the placement of the drainage tube, it's crucial to daily evaluate the patient's level of cooperation and self-care capability. Furthermore, both patients and their families should be educated on the importance of bed rest during and after drainage when a chest cavity insertion is performed[37]. Additionally, patients should be instructed on how to improve their self-care abilities, emphasizing the significance of thorough self-examination and the proper fixation of the drainage bag during activities to prevent gravity-induced dislodgement of the drainage tube[38,39].

Patients in this study generally presented with milder conditions, as indicated by an APACHE II score of ≤ 15. This was linked to their pronounced sense of independence, resulting in reduced cooperation, frequent out-of-bed activities, and an increased likelihood of inadvertently touching the drainage tube. Additionally, being elderly meant that their skin and muscle elasticity was diminished, making the drainage tube more susceptible to slipping[40,41]. Therefore, following the placement of the drainage tube, we must provide excellent patient education, appropriately reduce the patient's activity level, advise the patient to protect the drainage tube, intensify nutritional support therapy for patients, aim for an early recovery, and remove the drainage tube as soon as possible[42].

In conclusion, our research faced several limitations. Being a retrospective study, it had a restricted sample size and potentially lower data accuracy. Furthermore, the strain on nursing resources due to coronavirus disease 2019 might have influenced data collection, introducing potential biases.

CONCLUSION

Compared to the CVC, the indwelling thoracic catheter offers an immediate enhancement to lung function, rendering effective treatment for patients. Its advantages include a reduced risk of detachment or obstruction. For elderly patients with COPD complicated by spontaneous pneumothorax, the indwelling thoracic catheter is the recommended choice. Additionally, during surgical procedures, it's vital to securely fix the drainage tube, deliver meticulous postoperative care, educate patients on drainage tube maintenance, and emphasize the significance of these measures to prevent the thoracic closed drainage tube from detaching.

ARTICLE HIGHLIGHTS

Research background

Chronic obstructive pulmonary disease (COPD) complicated with spontaneous pneumothorax is characterized by a significant decline in lung function, even cardiopulmonary failure and hypoxia in severe cases, which is extremely harmful to the elderly. The common clinical treatment is closed thoracic drainage.

Research motivation

To provide more effective and high quality clinical nursing for elderly patients with COPD complicated with spontaneous pneumothorax.

Research objectives

To compare the clinical data of different drainage methods in elderly patients with COPD complicated with spontaneous pneumothorax, and to choose a more suitable drainage method for elderly patients with COPD complicated with spontaneous pneumothorax.

Research methods

Retrospectively analyzed.

Research results

The indwelling thoracic catheter offers an immediate enhancement to lung function, rendering effective treatment for elderly patients with COPD complicated by spontaneous pneumothorax.

Research conclusions

For elderly patients with COPD complicated by spontaneous pneumothorax, the indwelling thoracic catheter is the recommended choice.

Research perspectives

Comparative research perspective.

FOOTNOTES

Author contributions: Wang W and Bao J contributed equally to this work; Wang W designed the study; Zhu DN and Shao SS contributed to the analysis of the manuscript; Wang W and Bao J involved in the data and writing of this article; and all authors have read and approved the final manuscript.

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