Original Article

The effect of routine health exercises on the prevention of lower extremity deep vein thrombosis following pneumonectomy

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Abstract

Objective: To explore the clinical effects of procedural health exercises on the prevention of postoperative deep vein thrombosis in patients following pneumonectomy. In this manuscript patients who had thoracic surgery were included in this study to explore the effects of DVT after exercise.

Method: 118 patients admitted to the hospital from January to December 2020 were selected and assigned into two groups according to the time of admission. 51 patients from January to June 2020 were set as the control group, 67 patients from July to December 2020 were selected as part of the observation group. The control group was provided with routine nursing following a lung operation. The observation group was opened 6 hours after the operation except for the routine nursing. The blood flow velocity of the femoral vein and popliteal vein and the occurrence of deep vein thrombosis were compared between the two groups.

Results: There were three cases of lower extremity venous thrombosis in the observation group, which was significantly lower than that in the control group (6 cases). The blood flow velocity of the lower extremity deep vein in the observation group was higher than that of the control group ($p<0.05$).

Conclusion: Routine health exercises can effectively improve the blood flow velocity of the lower extremity vein, by reducing the incidence of lower extremity deep vein thrombosis following pneumonectomy, and by improving the quality of life of patients, which is worthy of clinical promotion.

Keywords: program health exercise; pneumonectomy; lung cancer; deep vein thrombosis

Introduction

Deep venous thrombosis (DVT) is one of the most common complications following lung cancer surgery. Compared with non-surgical patients, the risk of occurrence is at least 2 times higher, and the risk of pulmonary embolism is 3 times higher (1,2). The blood of lung cancer patients is generally in a state of hypercoagulability. Preoperative prohibition of drinking, anxiety and depressive mental states, excessive operation time, intraoperative use of hemostatic agents, etc., will all cause the body to be in a state of stress, increase blood viscosity, and cause severe depression. The formation of venous thrombosis (3), severe cases endanger the life of the patient. The prognosis of patients with lung cancer surgery not only depends on the success of the operation but are also directly related to whether measures can be taken to actively prevent deep vein thrombosis (4). Pneumonectomy has a higher perioperative complication and mortality rate as compared to other surgical methods, therefore medical staff should fully understand the relevant risk factors and take measures in advance to avoid the risks as much as possible, to improve the prognosis of patients. Some studies[5,6] indicated that the effective promotion of lower limb venous blood flow can be intervened through nursing interventions. In this study, procedural health exercises were used to provide early training and intervention for lung cancer patients following pneumonectomy to prevent the formation of deep vein thrombosis of the lower extremities.

Object and Method

Research objects

Selected patients who had pneumonectomy for lung cancer in the thoracic surgery department of a tertiary A-level specialist hospital from January to December 2020 were included in this study.

Inclusion criteria: (1) Inpatients who underwent VATS or thoracotomy pneumonectomy for the first time; (2) Those who had never received radiotherapy and/or chemotherapy; (3) Patients with complete clinical data and who volunteered to participate in the study.

Exclusion criteria: (1) patients with severe heart, liver, and kidney function diseases; (2) patients with mental diseases and communication disorders; (3) patients with incomplete clinical data. According to the patient's admission time, 52 patients from January to June 2020 were included in the control group, and 69 patients from July to December 2020 were included in the observation group. A total of three cases were lost to follow-up in this study. Among them, one patient in the observation group was transferred to the intensive care unit again, due to acute high-risk pulmonary embolism, one patient passed on due to severe pulmonary infection and one patient in the control group underwent secondary surgery due to a bronchopleural fistula. In the end, there were 118 participants in this study, including 67 in the observation group and 51 in the control group. There was no statistically significant difference in the general information between the

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two groups of patients (P>0.05), and they were comparable, as indicated in **Table 1**. This study complies with the requirements of the Declaration of Helsinki.

Table 1. **Comparison of general information of the two groups of patients**

Items	Observation group (n=67)	Control group (n=51)	P-value
Gender, n (%)			
Male	37 (55.2)	25 (49.0)	0.730
Female	30 (44.8)	26 (51.0)	
Age, years	61.30 ± 9.24	60.62 ± 9.71	0.651
Education, n (%)			
Junior high school and below	37 (55.2)	27 (52.9)	
High school or technical Secondary school	21 (31.3)	16 (31.4)	0.283
University and above	9 (13.4)	8 (15.7)	
Smoking history, n (%)			
Yes	29 (43.3)	22 (43.1)	0.492
No	38 (56.7)	29 (56.9)	
High hypertension, n (%)			
Yes	18 (26.9)	13 (25.5)	0.738
No	49 (73.1)	38 (74.5)	
Diabetes			
Yes	9 13.4	7 (13.7)	0.432
No	58 (84.6)	44 (86.3)	
BMI, kg/m^2	23.38 ± 0.4	23.40 ± 0.2	0.510
Length of operation, min	169.9 ± 12.4	173.2 ± 11.8	0.418
Surgical approach, n (%)			
VATS pneumonectomy	55 (82.1)	41 (80.4)	0.436
Thoracotomy pneumonectomy	12 (17.9)	10 (19.6)	

BMI: Body Mass Index; VATS: Video-assisted thoracoscopic surgery.

Control group

Patients in the control group were provided with nursing care according to the norms of "Nursing Routines for Thoracic Surgery", which specifically included regular admissions and education, preoperative education, and informing patients of early activities, etc.; postoperative routine care, respiratory tract management, catheter care, intravenous infusion care, and pain care, Functional exercise, health education, etc. Furthermore, the patient can shake the head of the bed 6 hours after the operation, and the patient is given a 45-60° laying position on the first day after the operation, and the patient is encouraged to perform limb activities on the bed; after the chest tube is removed, the surgical side and the supine position can be alternately positioned between 10-14 days, one week later, the condition allows you to get out of bed and move around. The patients who had been diagnosed with pneumonectomy had a risk of DVT of around 4% over a 5-year period. Patients who had surgery had a two to three-fold increased risk of developing VTE as compared to the patients who did not have surgery. On the other hand, cancer patients who had the same thoracic surgical procedure had at least double the risk of developing DVT as compared to patients who did not have surgery.

Observation group

In addition to the routine nursing for thoracic surgery, the patients in the observation group performed health exercises to prevent the development of DVT under the guidance and assistance of the responsible nurse 6 hours after the operation. Specific measures: ① Place a small cushion pillow on the heel of the patient, so that the patient`s calf is suspended in the air to form an angle of 20°with the bed surface. ② Instruct the patient to perform bilateral ankle exercises, do ankle dorsiflexion, plantar flexion, and circular rotation exercises at a frequency of 15-20 times/min, and repeat each action 20 times. ③ Instruct the patient to do knee extensions and flexion exercises, with a frequency of 15-20 times/min, and repeat these 20 times. ④ Paste the acupoints on the patient's Taichong and Sanyinjiao and instruct the patient to press the opposite side of the Taichong and Sanyinjiao with the contralateral heel to stimulate the acupoints to speed up the blood flow of the patient's lower limbs and reduce blood viscosity. ⑤ Assist the patient to turn over, alternately between the affected side and semi-recumbent position. ⑥ Encourage patients to take the initiative to exercise, including deep breathing exercises. Instruct patients to take deep breaths 10 times first, and then perform exercises. Activities ①-③ will be started 6 hours after the operation, and items ④-⑥ will be performed within 6-10 hours after the operation and performed once on the day of the operation.

Continue to perform items ①-⑥ on the first postoperative day, but gradually increase the amount of activity; the above training is carried out 4 times a day, respectively in the morning, afternoon and before going to bed; the patient`s activities are all assisted by nurses who have received uniform training and activities are completed under guidance.

Observation index

① The incidence of deep vein thrombosis in lower limbs was compared between the two groups.

② Color doppler flow image (CDFI): used to check the common femoral vein, popliteal vein blood flow velocity (maximum blood velocity, Vmax), and average blood flow velocity before and on the third day after surgery (mean blood velocity, Vm) and thrombosis.

Statistical methods

Statistical analysis was performed using SPSS 21.0 software. Measurement data was described using the mean ± standard deviation ($x \pm s$), and comparisons between the groups was performed using two independent samples T-tests or the repeated measures analysis of variance; count data was described using the number of cases and percentages. The X^2 test was used for comparisons between groups. $P<0.05$ indicates that the difference is statistically significant.

Results

Table (2) Comparison of postoperative deep venous thrombosis in lower limbs between the two groups

Table 2 Comparison of postoperative deep venous thrombosis in lower limbs between the two groups

Group		**Observation group**	**Control group**
Cases, n		67	51
No thrombus, n		64	45
Thrombosis, n	Anterior tibial vein thrombosis	1	2
	Posterior tibial vein thrombosis	1	2
	Peroneal Vein Thrombosis	1	1
	Deep femoral vein thrombosis	0	1
Total thrombosis rate		4.48%	11.76%
X^2		7.200	
P-value		0.007	

Comparison of blood flow velocity of lower limbs, common femoral vein and popliteal vein before and 3 days after the operation between the two groups (Table 3)

Table 3 Comparison of peak blood flow velocity and average velocity of common femoral vein and popliteal vein between the two groups

Items		**Observation group**	**Control group**	**T**	**p-value**
Cases, n		67	51	\	\
Common femoral vein Vmax, cm/s	Preoperative	24.4±3.6	24.2±3.9	0.794	0.428
	3d after surgery	58.7±4.6	47.2±3.8	24.161	＜0.01
Popliteal vein Vmax, cm/s	Preoperative	14.4±2.3	14.6±1.9	-1.221	0.223
	3d after surgery	31.5±3.7	24.6±4.6	4.559	＜0.01
Common femoral vein Vm, cm/s	Preoperative	14.9±3.1	14.3±2.6	0.528	0.598
	3d after surgery	32.5±7.6	25.1±4.2	5.378	＜0.01
Popliteal vein Vm, cm/s	Preoperative	8.5±2.3	8.3±2.7	0.358	0.591
	3d after surgery	25.2±4.5	17.5±4.2	8.561	＜0.01

Discussions

The effects of procedural health exercises on color Doppler blood flow imaging of patients after pneumonectomy: The color Doppler blood flow phenomenon indicates that the use of procedural exercises for lung cancer patients after pneumonectomy can effectively accelerate the blood flow velocity of the lower limbs, in both the peak

blood flow velocity of the common femoral vein and the popliteal veinboth are significantly improved, and the difference is statistically significant. There are many venous sinuses in the veins of the lower extremities, and the blood flow in the venous sinuses mostly depends on the contraction of the leg muscles to return to the heart (5). Studies have indicated that active and passive movement of the ankle and deep breathing training can effectively accelerate the speed of the femoral vein, especially the ankle joint plantar flexion and dorsiflexion, which can increase the peak femoral vein blood flow speed by 69.3% (6,7). The average speed increased by 69.1%, which is like the results of this study. Furthermore, the exercises are carried out in an orderly manner in accordance with the procedures and incorporate the concept of acupoint stimulation. Acupoint stickers are used to guide patients to stimulate the Taichong and Sanyinjiao points, which can not only improve and promote local blood circulation, but also enhance the anticoagulation mechanism in the blood (8). Stimulating the Taichong point can also expand the local venules, increase the blood flow speed, and fully improve the blood circulation of the lower limbs (9).

The effect of procedural health exercises on reducing the incidence of deep vein thrombosis in patients undergoing pneumonectomy

Patients undergoing pneumonectomy slow down the venous blood flow rate due to prolonged supine during the operation, immobilization, and continuous bed rest after the operation, etc. Surgery and anesthesia trauma can release tissue factors, directly activate the exogenous coagulation system, and form high blood coagulation state or thrombus; trauma can also cause tissue edema, causing the venous return disorder, thereby further activating the coagulation system, and forming thrombus (10,11). The formation of thrombus is the result of multiple factors. In this study, a Caprini risk assessment was conducted for patients following pneumonectomy, and the intervention of procedural health exercises was performed for patients following their surgeries. Early activity training and intervention of procedural health exercises was provided for patients and their families 1 day before surgery, by explaining and demonstrating proactive health exercises in bed, and by sharing the video of health exercises through social media and including a bedside multimedia education machine to facilitate patients learning ability for the various techniques. After the operation, the nurse in charge of the operation guided and supervised the completion of the next step, which ensured the implementation quality of the health exercises. The exercises moved the patient's activity time forward after surgery, starting at 6 hours after surgery, proceeding step by step, and following the steps one by one. At the same time, it incorporated the concept of TCM acupoint stimulation. The use of acupoint stickers guided the patient to stimulate the acupoints and promotes the patient's lower extremity venous return, which was effective in reducing the incidence of deep vein thrombosis of the lower extremities. There were no significant side effects for the treatments used in this study.

In conclusion, the training of procedural health exercises combines passive and autonomous activities for patients and health exercises also incorporate the concept of traditional Chinese medicine, with acupoint stimulation to speed up the blood flow rate of the patient's lower limbs and reduce blood viscosity. The implementation of procedural health exercises for patients undergoing pneumonectomy can reduce the occurrence of deep vein thrombosis in the lower limbs after surgery and promote early recovery of patients. It is worthy of further promotion and use in the clinic setting.

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Contributions

(I) Conception and design: XX Yan, B Chen, YJ Mao; (II) Administrative support: XX Yan, YJ Mao; (III) Provision of study materials or patients: XX Yan, B Chen; (IV) Collection and assembly of data: XX Yan, B Chen; (V) Data analysis and interpretation: XX Yan, YJ Mao; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

References

1. Tesselaar ME, Osanto S. Risk of venous thromboembolism in lung cancer. *Curr Opin Pulm Med.* 2007;13(5):362-367.
2. Yang Y, Zhou Z, Niu XM, et al. Clinical analysis of postoperative venous thromboembolism risk factors in lung cancer patients. *J Surg Oncol.* 2012;106(6):736-741.
3. Balabhadra S, Kuban JD, Lee S, et al. Association of Inferior Vena Cava Filter Placement With Rates of Pulmonary Embolism in Patients With Cancer and Acute Lower Extremity Deep Venous Thrombosis. *JAMA Netw Open.* 2020;3(7):e2011079.
4. Hirsh J, Dalen J, Guyatt G, American College of Chest P. The sixth (2000) ACCP guidelines for antithrombotic therapy for prevention and treatment of thrombosis. American College of Chest Physicians. *Chest.* 2001;119(1 Suppl):1S-2S.
5. Farge D, Debourdeau P, Beckers M, et al. International clinical practice guidelines for the treatment and prophylaxis of venous thromboembolism in patients with cancer. *J Thromb Haemost.* 2013;11(1):56-70.
6. Flevas DA, Megaloikonomos PD, Dimopoulos L, Mitsiokapa E, Koulouvaris P, Mavrogenis AF. Thromboembolism prophylaxis in orthopaedics: an update. *EFORT Open Rev.* 2018;3(4):136-148.

7. Calder JD, Freeman R, Domeij-Arverud E, van Dijk CN, Ackermann PW. Meta-analysis and suggested guidelines for prevention of venous thromboembolism (VTE) in foot and ankle surgery. *Knee Surg Sports Traumatol Arthrosc.* 2016;24(4):1409-1420.
8. Arichi S, Arichi H, Toda S. Acupuncture and rehabilitation (III) effects of acupuncture applied to the normal side on osteoarthritis deformans and rheumatoid arthritis of the knee and on disorders in motility of the knee joint after cerebral hemorrhage and thrombosis. *Am J Chin Med.* 1983;11(1-4):146-149.
9. Shi G. Clinical application of the point taichong. *J Tradit Chin Med.* 2002;22(4):291-293.
10. Akhtar-Danesh GG, Akhtar-Danesh N, Shargall Y. Venous Thromboembolism in Surgical Lung Cancer Patients: A Provincial Population-Based Study. *Ann Thorac Surg.* 2021.
11. Raja S, Idrees JJ, Blackstone EH, et al. Routine venous thromboembolism screening after pneumonectomy: The more you look, the more you see. *J Thorac Cardiovasc Surg.* 2016;152(2):524-532 e522.