RESEARCH ARTICLE

Analysis of ICU Treatment on Resection of Giant Tumors in the Mediastinum of the Thoracic Cavity

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Abstract

Objective: The purpose of this study was to assess prognosis after resection of giant tumors (including lobectomy or pneumonectomy) in the mediastinum. Materials and Methods: Patients with resection of a giant tumor in the mediastinum of the thoracic cavity received ICU treatment including dynamic monitoring of vital signs, arterial blood pressure and CVP detection, determination of hemorrhage, pulmonary function and blood gas assay, treatment of relevant complications, examination and treatment with fiber optic bronchoscopy, transfusion and hemostasis as well as postoperative removal of ventilators by invasive and non-invasive sequential mechanical ventilation technologies. Results: Six patients were rehabilitated successfully after ICU treatment with controlled postoperative errhysis and pulmonary infection by examination and treatment with fiber optic bronchoscopy without second application of ventilators and tubes after sequential mechanical ventilation technology. One patient died from multiple organ failure under ICU treatment due to postoperative active hemorrhage after second operative hemostasis. Conclusions: During peri-operative period of resection of giant tumor (including lobectomy or pneumonectomy) in mediastinum ofthe thoracic cavity, the ICU plays an important role in dynamic monitoring of vital signs, treatment of postoperative stress state, postoperative hemostasis and successful removal of ventilators after sequential mechanical ventilation.

Keywords: Giant tumor in mediastinum of thoracic cavity - ICU - treatment during the peri-operative period

Asian Pacific J Cancer Prev, **14 (6)**, 3843-3846

Introduction

Peri-operative treatments that are important for patients with resection of giant tumor in mediastinum of thoracic cavity are complicated because of serious trauma, bleeding (more than is normal), damage of phrenic nerves and lobectomy or pneumonectomy due to invasion of tumors to pulmonary tissues in operation, which have great influence on the successful rehabilitation postoperatively (Dwivedi et al., 2013; Mitsui et al., 2013; Tu et al., 2013). And the hemorrhagic stroke caused by postoperative hemorrhage and its exudation as well as the recovery of respiratory function after operation are especially crucial for the successful treatment (Hui et al., 2012; Takahashi et al., 2013). This study summarized the ICU treatment for patients with resection of giant tumor in mediastinum of thoracic cavity admitted from January, 2012 to January, 2013 in our hospital, and obtained favorable advancement under the support of respiratory, hemostatic and circulative systems as well as sequential mechanical ventilation.

Materials and Methods

General Data

Patients with resection of giant tumor in mediastinum of thoracic cavity were enrolled from January, 2012 to January, 2013 in our hospital with 4 males and 3 females. Research results of our Institute have been described elsewhere (Liu et al., 2012; Sun et al., 2012; Han et al., 2013). CT scan of typical giant tumors in mediastinum of thoracic cavity are shown in Figure 1. All patients had involvement of respiratory function and dyspnea to some degree with respiratory rates being 23.6±5.6 times/minute. Results of blood gas assay indicated the retention of carbon dioxide (CO_2) being PH: 7.34±0.28 and $PaCO_2$: 53.2±6.8 mmHg. Patients with simple tumors were excluded from this research.

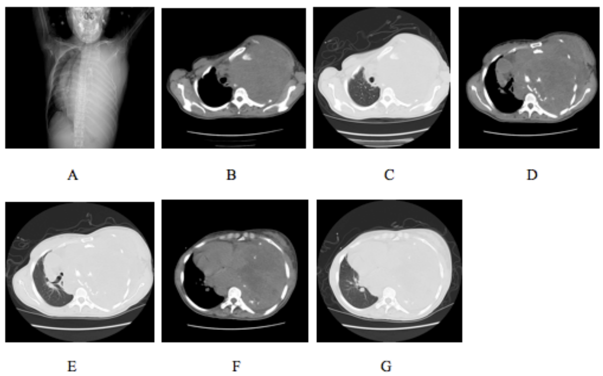

Figure 1. Typical Symptoms of Giant Tumors in Mediastinum of Thoracic Cavity

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Methods

Preoperative preparations and surgery: all patients received resection of giant tumor (including lobectomy or pneumonectomy) in mediastinum of thoracic cavity following routine preoperative preparations and cases discussion with relevant departments of surgery, ICU and anesthesiology and were given routine treatment of ICU and appropriate measures in accordance with their special conditions. Tracheal cannulas and mechanical ventilation were still needed in ICU wards after operation.

Postoperative ICU treatment

ICU detection and treatment: routine detection of vital signs. CVP detection were established with mean value being 7 cm H_2O and invasive arterial pressure detection were set up with maintained blood pressure being 90-120/50-70 mmHg. As for patients with hypertension, proper sedatives were applied and 12.5-25 mg Urapidil hydrochloride was intravenously injected or 3-10 μg/(min.kg) was pumped according to the sustained hypertension. Blood components transfusion was adopted for hypotension caused mainly by intra-operative hemorrhage and postoperative errhysis, including suspension red blood cells and plasma, etc.. 3-10 μg/(min.kg) dopamine was pumped if blood pressure was still < 80 mmHg after supplementing 2/3 of the lost fluid and the dosage could be regulated based on blood pressure. Detection of bleeding amount: position of trachea, pressure in thoracic cavity and duct on operated side were observed and the errhysis in thoracic cavity on operated side was comprehensively diagnosed combined with vital signs. The volume and speed of transfusion consisting of fresh plasma rich in platelets and blood coagulation factors were determined in the light of drainage volume while vitamin K was also used together with hemostatics.

Fiber optic bronchoscopy and treatment

Fiber optic bronchoscopy was applied postoperatively, aiming at locating the position of tracheal cannulas and protecting unilateral pneumonectomy to avoid the damage from the application of suction catheters. With regard to patients able to remove ventilators, bronchoscope could be used to suck sputum during sequential mechanical ventilation. X-ray chest radiotherapy and dynamic blood gas assay were taken at bed after operation. The volume and color of sputum sucked and the results of blood gas assay were recorded before and after sputum suction.

Remove of ventilators and tubes using sequential mechanical ventilation

The ventilators and tubes were removed 18-36 h after operation when patients were fully conscious with stable surgical conditions and closed drainage volume being < 30 mL/h or < 20 mL/h in 6 h. Then invasive mechanical ventilation were given with bi-level positive airway pressure (BiPAP) through oral-nasal mask, and patients were encouraged to sit up and assisted with expectoration by slapping backs. Sputum suction with fiber optic bronchoscopy was given 24 h after remove of ventilators and tubes. Vital signs were recorded, blood gas assay was dynamically detected, the change of respiratory rates and dyspnea during sequential mechanical ventilation were observed and the results were recorded combined with blood gas assay.

Statistical data analysis

SPSS13.0 software was applied and enumeration data was presented as mean ± standard deviation ($\overline{\chi}\pm s$). T test was used to compare the means of two groups and P < 0.05 was regarded as statically significant.

Results

Results of respiratory rates and blood gas assay before and after sputum suction with fiber optic bronchoscopy in 6 patients

One patient died from multiple organ failure in ICU treatment due to postoperative active hemorrhage after second operative hemostasis. Sputum suction with fiber optic bronchoscopy in 6 patients could improve oxygenated function and reduce respiratory rates and retention of CO_2 (Table 1). The average respiratory rates before and after sputum suction were 27.67±2.41

Table 1. Results of Respiratory Rates and Blood Gas Assay Before and after Sputum Suction with Fiber Optic Bronchoscopy

Cases	Before sputum suction				After sputum suction			
	Respiratory rates (times/min)	PH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)	Respiratory rates (times/min)	PH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)
1	28	7.36	67	60	25	7.42	48	77
2	26	7.37	59	56	22	7.40	45	90
3	31	7.35	65	72	26	7.39	51	84
4	26	7.39	68	57	24	7.43	40	85
5	30	7.34	57	54	24	7.41	39	66
6	25	7.32	78	61	26	7.38	42	72

Table 2. Results of Respiratory Rates and Blood Gas Assay During Operation and in ICU

Cases	Invasive ventilator treatment during operation				Invasive ventilator treatment in ICU			
	Respiratory rates (times/min)	PH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)	Respiratory rates (times/min)	PH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)
1	30	7.37	49	72	15	7.45	41	135
2	28	7.35	59	80	18	7.43	39	130
3	33	7.36	50	65	20	7.43	42	108
4	27	7.33	58	71	17	7.40	40	125
5	26	7.38	55	76	16	7.38	43	128
6	31	7.34	67	68	18	7.41	45	119
Mean	29.17±2.64	7.36±0.02	56.33±6.62	72.00±5.40	17.33±1.75**	7.42±0.03**	41.67±2.16**	124.17±9.54**

Compared with treatment during operation, **P<0.01

Table 3. Results of Respiratory Rates and Blood Gas Assay Before and after Treatment of Non-invasive Ventilators

Cases	Before non-invasive ventilator treatment (after remove of ventilators and tubes)				Non-invasive ventilator treatment			
	Respiratory rates (times/min)	PH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)	Respiratory rates (times/min)	PH	$PaCO_2$ (mmHg)	PaO_2 (mmHg)
1	28	7.34	71	74	22	7.40	48	94
2	30	7.33	65	80	26	7.37	45	85
3	26	7.35	58	72	24	7.44	50	105
4	32	7.33	63	75	23	7.41	43	97
5	27	7.34	68	80	20	7.40	45	89
6	31	7.33	70	73	24	7.36	51	95
Mean	29.00±2.37	7.34±0.01	65.83±4.88	75.67±3.50	23.17±2.04**	7.40±0.03**	47.00±3.16**	94.17±6.88**

Compared with treatment during operation, ***P*<0.01

times/min and 24.51±1.52 times/min respectively with significant differences between ($P < 0.05$) while $PaCO_2$ (65.67±7.47 mmHg) after sputum suction was evidently lower than that (60.00±6.42 mmHg) before ($P < 0.01$). Additionally, PaO_2 were 60.00±6.42 mmHg and 79.00±8.99 mmHg before and after sputum suction respectively and the differences were of great significance ($P < 0.01$). However, the respiratory rates in two groups were not seen with any differences ($P > 0.05$).

Results of respiratory rates and blood gas assay before and after treatment of ventilator

Results of respiratory rates and blood gas assay after 18-36 h invasive mechanical ventilation in 6 patients after operation were recorded. As shown in Table 2, respiratory rates and $PaCO_2$ decreased while PH and PaO_2 increased significantly ($P < 0.01$) in ICU than during operation. However, the results after 72 h of non-invasive mechanical ventilation following the remove of ventilators and tubes also showed significant decreases in respiratory rates and $PaCO_2$ and increases in PH and PaO_2 ($P < 0.01$).

Discussion

Neurogenic tumors are the most in amount in mediastinum of thoracic cavity, followed by teratoma in anterior mediastinum, tumors of thymus and substernal thyroid tumors in sequence. Tumors in mediastinum of thoracic cavity are commonly overlooked due to their unobvious clinical symptoms and are discovered being in advanced stage by physical examination or from corresponding clinical symptoms of tissues and organs (Cheung, 2012; Komatsu et al., 2013; Montaruli et al., 2013). Diameter of tumor ≥10 cm is considered as giant tumor in mediastinum of thoracic cavity as there is still no uniform opinion on clinical diagnostic standard for it (Kumar et al., 2012; Ong et al., 2012). Giant tumor in mediastinum of thoracic cavity often results in change of anatomical structures of the surrounding tissues and organs because of its adhesion with thoracic walls, pericardium and pulmonary tissues, etc., which multiply the difficulties for clinical treatment and surgeries on account of its tough exposure and dissociation (Ishibashi et al., 2012; Zencirci et al., 2012). Seven patients with giant tumor in mediastinum of thoracic cavity admitted in our hospital with damaged respiratory function, increased respiratory rates, slight retention of CO_2 and normal oxygenation after oxygen inhalation were given surgeries following preoperative preparations. As for patients likely to get hemorrhagic stroke due to plenty of intra-operative hemorrhage and postoperative errhysis, blood components transfusion (including fresh frozen plasma rich in blood coagulation factors) combined with hemostatics were administrated based on the rigorous postoperative detection in ICU. Along with hematosis, controlled hypertension was needed to decrease postoperative errhysis in patients with hypertension. In conclusion, advancements were gained in maintaining postoperative circulatory stability (Boyd et al., 2012; Sirotkina et al., 2012; Tantisattamo et al., 2012).

Diagnosis and treatment with fiber optic bronchoscope is necessary during peri-operative period. Early application of bronchoscope is to locate tracheal cannula and then observe the effect of suction catheter on tracheal stump of operated side during sputum suction after patients returning to ICU with tracheal cannulas (Daiko et al., 2012; Kajiwara et al., 2012; Komasawa et al., 2012; Spartalis et al., 2012). Meanwhile, the sputum suction from the remaining pulmonary tissues on affected side or lung deposition on healthy side after operation is conducive to the prevention of postoperative pulmonary infection. Resection of giant tumor in mediastinum of thoracic cavity is often accompanied with damage of phrenic nerves, bringing about inconsistent respiration because of difficult expectoration and then the respiratory functional impairment of diaphragmatic muscle on operated side. And the decrease of respiratory area due to pneumonectomy on operated side can increase the difficulty in removing ventilators. Sequential mechanical ventilation in postoperative treatment in ICU can shorten the service time of ventilators and reduce the probability of second application of cannulas with significant value in sputum suction with bronchoscope (Zielińska-Krawczyk et al., 2011; Fujinaga et al., 2012; Ruan et al., 2012).

Sequential mechanical ventilation during peri-operative period mainly aims to treat patients with difficulty in postoperative remove of ventilators due to insufficient respiratory function caused by the damage of respiratory function, diaphragmatic muscles and phrenic nerves after resection of giant tumor in mediastinum of thoracic cavity. Long-term application of ventilators can easily add difficulties for removing ventilators because of ventilator-relevant pulmonary infection or adopt second application due to respiratory failure after forced remove of the machine (Cardillo et al., 2008; Ipek et al., 2012). It is also effective in COPD combined with acute respiratory failure. Non-invasive mechanical ventilation following early remove of invasive ventilators can improve the insufficient respiratory function without the adverse reactions caused by immobilization during invasive mechanical ventilation, especially thrombotic diseases and tracheal cannula-induced aspiration pneumonia. It can also be better used in patients in stable surgical conditions who are conscious and willing to cooperate in clinic and be positively used after remove of tracheal cannulas. Moreover, non-invasive ventilators can reduce respiratory rates, improve oxygenation and remit respiratory distress syndromes, which can be easily accepted and used repeatedly. Sequential application of non-invasive ventilator combined with early bed activities can effectively reduce postoperative complications. Patients with some degree of anoxia and retention of CO_2 after removing ventilators and tubes are assisted to suck sputum by slapping backs and with bed activities combined with the utilization of bronchoscope and non-invasive ventilators. In one word, ICU provides favorable measures for the rehabilitation of patients with abundant experiences.

Acknowledgements

On this occasion, the authors thank all study participants and colleagues of Department of Thoracic Surgery of Beijing Chest Hospital Affiliated to Capital Medical University, for their great support and contributions in this study. They are also thankful to physicians in Department of Thoracic Surgery for their treatments on patients with successful rehabilitation during peri-operative period of ICU. Grateful acknowledge goes to the colleagues once again.

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