

## • 论著 •

# 纤维支气管镜肺泡灌洗联合振动排痰治疗重症肺炎机械通气患者的效果观察：一项286例患者前瞻性随机对照研究

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**【摘要】目的** 探讨纤维支气管镜(纤支镜)肺泡灌洗联合振动排痰对重症肺炎机械通气(MV)患者的效果。**方法** 采用前瞻性随机对照临床研究方法,选择2014年1月至2016年7月湖南省人民医院重症加强治疗病房(ICU)收治的286例重症肺炎MV患者,按随机数字表法分为对照组和观察组,每组143例。两组患者均给予敏感抗菌药物抗感染、原发病治疗及温湿化治疗;对照组采用纤支镜肺泡灌洗治疗,观察组在对照组基础上联合振动排痰治疗。比较两组患者治疗前后呼吸功能指标、炎症指标及疗效和预后指标。**结果** ①治疗前两组呼吸功能指标无明显差异;治疗2 h后各指标均明显改善,且观察组氧合指数( $\text{PaO}_2/\text{FiO}_2$ )明显高于对照组[mmHg(1 mmHg=0.133 kPa):  $379.1 \pm 20.2$  vs.  $351.8 \pm 24.7$ ],动脉血二氧化碳分压( $\text{PaCO}_2$ )及气道阻力(Raw)均明显低于对照组[ $\text{PaCO}_2$ (mmHg):  $36.5 \pm 5.8$  vs.  $45.3 \pm 6.9$ , Raw(cmH<sub>2</sub>O, 1 cmH<sub>2</sub>O=0.098 kPa):  $12.9 \pm 0.6$  vs.  $13.1 \pm 0.8$ , 均  $P < 0.01$ ]。②治疗前两组炎症指标无明显差异;治疗24 h后各指标均明显下降,且观察组白细胞计数(WBC)、降钙素原(PCT)、C-反应蛋白(CRP)较对照组降低更为显著[WBC( $\times 10^9/\text{L}$ ):  $8.2 \pm 1.7$  vs.  $12.8 \pm 3.7$ , PCT(μg/L):  $15.4 \pm 2.4$  vs.  $21.8 \pm 3.1$ , CRP(mg/L):  $37.1 \pm 6.1$  vs.  $67.2 \pm 7.2$ , 均  $P < 0.01$ ]。③与对照组比较,观察组总有效率明显提高[95.1%(136/143) vs. 87.4%(125/143)],排痰量明显增多(mL:  $49.2 \pm 12.5$  vs.  $36.9 \pm 11.0$ ),MV时间和ICU住院时间明显缩短(d:  $6.4 \pm 3.6$  vs.  $9.4 \pm 2.1$ ,  $8.6 \pm 5.7$  vs.  $12.4 \pm 4.6$ , 均  $P < 0.01$ );但对照组与观察组28 d病死率差异无统计学意义[2.8%(4/143) vs. 2.1%(3/143),  $P > 0.05$ ]。**结论** 与单纯纤支镜肺泡灌洗比较,联合振动排痰治疗重症肺炎MV患者可通过有效排痰改善呼吸功能,减轻炎症反应,缩短MV时间及ICU住院时间,提高疗效,促进患者康复。

**【关键词】** 机械通气； 纤维支气管镜肺泡灌洗； 振动排痰； 肺炎,重症

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**Effect of bronchoalveolar lavage with fiberoptic bronchoscopy combined with vibration sputum drainage on mechanically ventilated patients with severe pneumonia: a prospective randomized controlled trial in 286 patients** Shi Zeya, Qin Yuelan, Zhu Yimin, Pan Xiaoji, Zhou Xu, Tan Yuting, Liu Yanhui

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**【Abstract】Objective** To investigate the curative effect of bronchoalveolar lavage with fiberoptic bronchoscopy combined with vibration sputum drainage in the treatment of severe pneumonia patients undergoing mechanical ventilation (MV). **Methods** A prospective randomized controlled trial was conducted. 286 severe pneumonia patients undergoing MV admitted to intensive care unit (ICU) of Hunan People's Hospital from January 2014 to July 2016 were enrolled, and they were divided into control group and observation group according to random number table, with 143 patients in each group. Patients in both groups received sensitive antibiotics for anti-infection, etiological treatment, and calefacient and humidifying treatment. The patients in the control group received bronchoalveolar lavage with fiberoptic bronchoscopy, and those in the observation group received bronchoalveolar lavage combined with vibration sputum drainage. The parameters of respiratory function and inflammation before and after treatment, curative effect, and prognosis were compared between the two groups. **Results** ① There were no significant differences in respiratory function parameters between the two groups before treatment, 2 hours after treatment, the parameters were improved in both groups. Moreover, oxygenation index ( $\text{PaO}_2/\text{FiO}_2$ ) in observation group was significantly higher than that of control group [mmHg (1 mmHg = 0.133 kPa):  $379.1 \pm 20.2$  vs.  $351.8 \pm 24.7$ ], and arterial partial pressure of carbon dioxide ( $\text{PaCO}_2$ ) and airway resistance (Raw) were significantly lower than those of the control group [ $\text{PaCO}_2$  (mmHg):  $36.5 \pm 5.8$  vs.  $45.3 \pm 6.9$ , Raw (cmH<sub>2</sub>O, 1 cmH<sub>2</sub>O = 0.098 kPa):  $12.9 \pm 0.6$  vs.  $13.1 \pm 0.8$ , all  $P < 0.01$ ]. ② There were no significant differences in inflammation parameters between the two groups before treatment, 24 hours after intervention, which were significantly decreased in both groups. Moreover, white blood cell count (WBC), procalcitonin (PCT) and C-reactive protein (CRP) in the observation group were significantly lower than those of the control group [WBC ( $\times 10^9/\text{L}$ ):  $8.2 \pm 1.7$  vs.  $12.8 \pm 3.7$ , PCT (μg/L):  $15.4 \pm 2.4$  vs.  $21.8 \pm 3.1$ , CRP (mg/L):  $37.1 \pm 6.1$  vs.  $67.2 \pm 7.2$ , all  $P < 0.01$ ]. ③ With comparison of control group, the total effective rate of observation group was significantly improved [95.1% (136/143) vs. 87.4% (125/143)], the sputum volume was significantly increased (mL:  $49.2 \pm 12.5$  vs.  $36.9 \pm 11.0$ ), the MV time and ICU hospitalization time were significantly shortened (d:  $6.4 \pm 3.6$  vs.  $9.4 \pm 2.1$ ,  $8.6 \pm 5.7$  vs.  $12.4 \pm 4.6$ , all  $P < 0.01$ ); but the mortality difference between the two groups at 28 days was not statistically significant [2.8% (4/143) vs. 2.1% (3/143),  $P > 0.05$ ]. **Conclusion** Compared with simple bronchoalveolar lavage, combined vibration sputum drainage treatment for severe pneumonia MV patients can effectively improve sputum drainage, improve respiratory function, reduce inflammatory response, shorten MV time and ICU hospitalization time, and promote patient recovery.

vs.  $12.8 \pm 3.7$ , PCT ( $\mu\text{g/L}$ ):  $15.4 \pm 2.4$  vs.  $21.8 \pm 3.1$ , CRP ( $\text{mg/L}$ ):  $37.1 \pm 6.1$  vs.  $67.2 \pm 7.2$ , all  $P < 0.01$ ]. ③ Compared with the control group, the treatment efficiency of observation group was improved [95.1% (136/143) vs. 87.4% (125/143)], the quantity of sputum excretion was increased (mL:  $49.2 \pm 12.5$  vs.  $36.9 \pm 11.0$ ), duration of MV and length of ICU stay were significantly shortened (days:  $6.4 \pm 3.6$  vs.  $9.4 \pm 2.1$ ,  $8.6 \pm 5.7$  vs.  $12.4 \pm 4.6$ , both  $P < 0.01$ ), however, there was no significantly statistical difference in 28-day mortality between control group and observation group [2.8% (4/143) vs. 2.1% (3/143),  $P > 0.05$ ]. **Conclusion** Compared with bronchoalveolar lavage with fiberoptic bronchoscopy alone, the treatment of bronchoalveolar lavage combined with vibration sputum drainage is more effective in sputum excretion for severe pneumonia patients undergoing MV, which could improve the respiratory function, reduce infection, shorten the duration of MV and the length of ICU stay, and improve the recovery.

**【Key words】** Mechanical ventilation; Bronchoalveolar lavage with fiberoptic bronchoscopy; Vibration sputum drainage; Severe pneumonia

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重症加强治疗病房(ICU)重症肺炎是由多种细菌混合感染或致病力较强的细菌或耐药菌导致的感染,单纯应用抗菌药物难以控制。机械通气(MV)时使用镇静剂或肌松剂、气道干燥导致纤毛运动减弱、咳嗽反射抑制、分泌物潴留,都可造成大量黏稠分泌物在深部支气管积聚,堵塞气道,引起肺通气和换气功能损害,导致MV效果差,患者预后不良甚至死亡<sup>[1]</sup>。纤维支气管镜(纤支镜)肺泡灌洗是近年来发展起来的诊疗方式,可在直视下清除气管分泌物,有效改善气管通气和换气功能,成为重症肺炎的重要治疗手段。然而,由于重症肺炎MV患者痰液多且黏稠,痰痂堵塞肺内细小气道,影响纤支镜肺泡灌洗效果,导致10%~20%患者纤支镜肺泡灌洗效果差<sup>[2]</sup>。振动排痰治疗通过对肺部的振动和定向叩击作用,使黏附在支气管黏膜表面的黏液及代谢物松脱,并从细小气道移动至大气道,对清除和移动肺内部支气管等小气道痰痂及分泌物有明显作用<sup>[3]</sup>。因此,纤支镜肺泡灌洗前给予振动排痰治疗可能会改善临床疗效,但相关报道较少。本研究旨在探讨纤支镜肺泡灌洗联合振动排痰治疗重症肺炎MV患者的效果及预后。

## 1 资料与方法

**1.1 一般资料:**采用前瞻性随机对照临床研究方法,选择2014年1月至2016年7月本院ICU收治的286例接受有创MV的重症肺炎患者作为研究对象。按照随机数字表法分为对照组和观察组,每组143例。

**1.1.1 纳入标准:**①符合重症肺炎诊断标准<sup>[4]</sup>;②有纤支镜肺泡灌洗治疗指征;③年龄18~60岁。

**1.1.2 排除标准:**①有振动排痰和(或)肺泡灌洗禁忌证;②不愿意参加本研究。

**1.1.3 脱落标准:**①患者中途改变意愿,拒绝配合;②在灌洗排痰过程中病情突然加重或死亡。

**1.1.4 伦理学:**本研究经医院医学伦理委员会批准(2015-05),纳入对象均被告知研究事项后签署知情同意书。实行双盲原则,受试者对分组不知情,避免偏倚;观察及测量数据均由课题组以外的2名经过统一方法培训的主治医师用相同检查仪完成,以最大程度减小误差。

**1.2 治疗方法:**由ICU同一组医护人员进行诊疗护理,所有患者均给予敏感抗菌药物抗感染、原发病治疗及温湿化治疗。

**1.2.1 对照组:**患者接受纤支镜肺泡灌洗治疗,使用多功能监护仪进行心电、血压及脉搏血氧饱和度( $\text{SpO}_2$ )监测,并将吸入氧浓度( $\text{FiO}_2$ )调整为1.00,气管套管内滴入2%利多卡因2 mL。气管导管内插入纤支镜,X线检测指导下依次在各叶、段及亚段支气管吸出痰液,并记录排痰量(总量—生理盐水)。在病变肺段支气管开口处取痰液进行细菌培养和药敏试验,用生理盐水灌洗至流出液澄清,每次灌洗量不超过100 mL,退出纤支镜。

**1.2.2 观察组:**于纤支镜肺泡灌洗前20 min,采用TC-818振动排痰仪进行振动排痰治疗,患者取健侧卧位,根据患者情况选择不同频率叩击背部,由外向内、自下而上进行振动排痰,每次叩击完成后再次行纤支镜肺泡灌洗。

## 1.3 观察指标及方法

**1.3.1 呼吸功能指标:**于治疗前和治疗2 h后测定氧合指数( $\text{PaO}_2/\text{FiO}_2$ )、动脉血二氧化碳分压( $\text{PaCO}_2$ )和气道阻力( $\text{Raw}$ )。

**1.3.2 炎症指标:**于治疗前和治疗24 h后取桡动脉血,检测白细胞计数(WBC)、降钙素原(PCT)和C-反应蛋白(CRP)水平。

**1.3.3 疗效及预后指标:**根据疗效判定标准<sup>[5]</sup>记录患者治疗显效、有效、无效例数,计算总有效率[(显效+有效)/总例数×100%]。记录患者MV

时间、ICU 住院时间及 28 d 病死率。患者治疗后每 5 d 进行 1 次胸部 CT 检查。

**1.4 统计学方法:** 应用 SPSS 18.0 统计软件进行数据分析。先进行正态性检验, 符合正态分布的计量资料以均数 ± 标准差 ( $\bar{x} \pm s$ ) 表示, 两组间若方差齐则采用成组 *t* 检验, 若方差不齐则采用 Wilcoxon 秩和检验, 组内两两比较采用自身前后配对 *t* 检验。计数资料以百分比 (%) 表示, 组间比较采用  $\chi^2$  检验。以  $P < 0.05$  表示差异有统计学意义。

## 2 结 果

**2.1 两组基线资料比较(表 1):** 286 例患者全部完成临床研究, 无中途脱落。两组患者性别、年龄、基础疾病、简化临床肺部感染评分(CPIS)、急性生理学与慢性健康状况评分系统 II(APACHE II) 评分等基线数据比较差异无统计学意义(均  $P > 0.05$ ), 说明两组基线资料均衡, 具有可比性。

表 1 纤维支气管镜肺泡灌洗是否联合振动排痰治疗两组重症肺炎机械通气患者一般资料比较

组别	例数 (例)	性别(例)		年龄 (岁, $\bar{x} \pm s$ )	基础疾病[例(%)]			简化 CPIS (分, $\bar{x} \pm s$ )	APACHE II (分, $\bar{x} \pm s$ )
		男性	女性		MOF	慢性消耗病	其他		
对照组	143	65	78	59.0 ± 4.9	70(48.9)	21(14.7)	21(14.7)	7.2 ± 1.6	24.7 ± 6.5
观察组	143	68	75	58.2 ± 5.2	66(46.1)	18(12.6)	25(17.5)	6.9 ± 1.8	25.0 ± 5.9
$\chi^2/t$ 值		0.126	1.339			1.226		1.490	0.409
<i>P</i> 值		0.722	0.182			0.874		0.137	0.683

注: MOF 为多器官功能衰竭, CPIS 为临床肺部感染评分, APACHE II 为急性生理学与慢性健康状况评分系统 II

表 2 纤维支气管镜肺泡灌洗是否联合振动排痰治疗两组重症肺炎机械通气患者治疗前后呼吸功能指标变化比较( $\bar{x} \pm s$ )

组别	例数 (例)	PaO <sub>2</sub> /FiO <sub>2</sub> (mmHg)		PaCO <sub>2</sub> (mmHg)		Raw (cmH <sub>2</sub> O)	
		治疗前	治疗 2 h	治疗前	治疗 2 h	治疗前	治疗 2 h
对照组	143	281.9 ± 20.7	351.8 ± 24.7 <sup>a</sup>	47.2 ± 10.4	45.3 ± 6.9 <sup>a</sup>	22.0 ± 1.0	13.1 ± 0.8 <sup>a</sup>
观察组	143	283.0 ± 19.5	379.1 ± 20.2 <sup>a</sup>	47.1 ± 12.5	36.5 ± 5.8 <sup>b</sup>	24.0 ± 1.1	12.9 ± 0.6 <sup>a</sup>
<i>t</i> 值		0.463	10.231	0.481	13.581	0.730	44.402
<i>P</i> 值		0.644	0.000	0.631	0.000	0.467	0.000

注: PaO<sub>2</sub>/FiO<sub>2</sub> 为氧合指数, PaCO<sub>2</sub> 为动脉血二氧化碳分压, Raw 为气道阻力; 1 mmHg = 0.133 kPa, 1 cmH<sub>2</sub>O = 0.098 kPa; 与本组治疗前比较, <sup>a</sup>*P* < 0.05, <sup>b</sup>*P* < 0.01

表 3 纤维支气管镜肺泡灌洗是否联合振动排痰治疗两组重症肺炎机械通气患者治疗前后炎症指标变化比较( $\bar{x} \pm s$ )

组别	例数 (例)	WBC ( $\times 10^9/L$ )		PCT (μg/L)		CRP (mg/L)	
		治疗前	治疗 24 h	治疗前	治疗 24 h	治疗前	治疗 24 h
对照组	143	17.8 ± 1.8	12.8 ± 3.7 <sup>a</sup>	28.4 ± 3.6	21.8 ± 3.1 <sup>a</sup>	79.1 ± 8.7	67.2 ± 7.2 <sup>a</sup>
观察组	143	18.2 ± 1.9	8.2 ± 1.7 <sup>a</sup>	27.5 ± 4.1	15.4 ± 2.4 <sup>a</sup>	78.5 ± 9.3	37.1 ± 6.1 <sup>a</sup>
<i>t</i> 值		1.800	13.547	1.776	19.841	0.572	38.175
<i>P</i> 值		0.730	0.000	0.077	0.000	0.568	0.000

注: WBC 为白细胞计数, PCT 为降钙素原, CRP 为 C-反应蛋白; 与本组治疗前比较, <sup>a</sup>*P* < 0.05

表 4 纤维支气管镜肺泡灌洗是否联合振动排痰治疗两组重症肺炎机械通气患者疗效及预后指标比较

组别	例数(例)	总有效率[% (例)]	排痰量(mL, $\bar{x} \pm s$ )	机械通气时间(d, $\bar{x} \pm s$ )	ICU 住院时间(d, $\bar{x} \pm s$ )	28 d 病死率[% (例)]
对照组	143	87.4 (125)	36.9 ± 11.0	9.4 ± 2.1	12.4 ± 4.6	2.8 (4)
观察组	143	95.1 (136)	49.2 ± 12.5	6.4 ± 3.6	8.6 ± 5.7	2.1 (3)
$\chi^2/t$ 值		7.122	8.832	8.608	6.204	0.146
<i>P</i> 值		0.028	0.000	0.000	0.000	0.702

注: ICU 为重症加强治疗病房

### 3 讨 论

重症肺炎是ICU中常见的危重症,病情凶险,多合并呼吸衰竭(呼衰),常规全身应用抗菌药物治疗无法在病灶局部取得理想的药物浓度,治疗效果差<sup>[6]</sup>,病死率高达30%~40%<sup>[7-8]</sup>。研究结果显示,纤支镜引流可降低慢性阻塞性肺疾病急性加重期(AECOPD)患者在低咳嗽峰流速情况下的再插管率,避免通气时间延长<sup>[9]</sup>;在有创通气情况下对严重低氧血症合并呼衰患者的治疗有一定可行性<sup>[10]</sup>。研究显示,纤支镜肺泡灌洗克服了经验性抗菌药物治疗的盲目性,避免了吸痰管吸痰的低效率,可有效改善气道功能<sup>[11-12]</sup>,已成为重症肺炎MV患者的重要治疗手段。然而,仍有10%~20%的患者纤支镜肺泡灌洗的效果差<sup>[13]</sup>,分析其原因可能是纤支镜肺泡灌洗只能到达和吸取段以上支气管的痰液,而瘀滞在肺内小气道的痰痂和分泌物无法清除。有报道,振动排痰对清除和移动肺内部支气管等小气道痰痂和分泌物有明显作用,可保持呼吸道通畅,增加患者舒适度<sup>[14-15]</sup>;同时可明显提高AECOPD患者的疗效,缩短MV时间,有效预防呼吸机相关性肺炎(VAP)的发生<sup>[16]</sup>。然而,有关纤支镜肺泡灌洗联合振动排痰治疗重症患者疗效的研究较少,本研究通过探讨该治疗方案的有效性,旨在提升重症肺炎MV患者的肺泡灌洗效果,提高救治率,降低病死率,为临床治疗打开新的思路。

**3.1 纤支镜肺泡灌洗联合振动排痰治疗能有效改善患者呼吸功能:**重症肺炎患者最突出的临床症状是肺泡氧合功能损害,同时伴有Raw和呼吸肌作功增加、肺顺应性降低<sup>[17]</sup>。本研究中两组患者治疗前各项呼吸功能指标无明显差异;治疗2 h后呼吸功能均明显改善,且观察组PaO<sub>2</sub>/FiO<sub>2</sub>明显高于对照组,PaCO<sub>2</sub>及Raw明显低于对照组,说明纤支镜肺泡灌洗联合振动排痰治疗更有助于改善患者的呼吸功能。提高重症肺炎MV患者疗效的关键是将肺内细小气道黏痰与痰痂移动至大气道,便于纤支镜灌洗吸出。张佩英<sup>[18]</sup>发现,全肺灌洗术联合振动排痰治疗可缓解肺泡蛋白沉积症患者的呼吸困难症状,X线胸片示两肺浸润影明显减少,呼吸通气功能明显改善,弥散量明显增加。振动排痰仪根据物理定向叩击原理,一方面通过垂直于身体表面的垂直力,对支气管黏膜表面的黏液及代谢物起松弛作用;另一方面通过平行于身体表面的水平力,帮助支气管内液化的黏液排出体外,从而使重症肺炎MV患者

气道通畅,肺泡复张,Raw降低,通气和换气功能改善,PaCO<sub>2</sub>下降、PaO<sub>2</sub>/FiO<sub>2</sub>上升,促进呼吸功能恢复。

**3.2 纤支镜肺泡灌洗联合振动排痰治疗能有效减轻患者炎症反应:**因重症肺炎患者多存在严重基础疾病、免疫功能低下、长期卧床等多重感染因素,且应用呼吸机也易造成相关感染,患者处于全身严重感染状态,因此,痰液引流更显重要。WBC、PCT和CRP是临床常用于诊断感染的炎症指标,本研究发现,观察组患者接受纤支镜肺泡灌洗联合振动排痰治疗后WBC、CRP和PCT均明显低于对照组。黄静等<sup>[19]</sup>将50例VAP患者随机分组,对照组给予常规抗感染、营养支持、对症治疗及翻身叩背等护理,观察组在对照组基础上采用纤支镜肺泡灌洗联合机械振动排痰治疗,结果显示,观察组抗感染治疗总有效率明显高于对照组(96.00%比72.00%,P=0.02)。表明肺泡灌洗联合振动排痰能有效清除气道内的分泌物,并在一定程度上消除了致病因素,阻断了炎症反应,从而有效改善通气,形成良性循环。

**3.3 纤支镜肺泡灌洗联合振动排痰治疗有效率高,能改善患者预后:**治疗有效率、排痰量、MV时间、ICU住院时间、28 d病死率可反映重症肺炎MV患者的疾病转归及早期预后。治疗有效率由临床症状、排痰量、WBC、血气分析结果、CT结果、炎症病灶吸收情况等综合指标构成,直接反映振动排痰治疗对于提升纤支镜肺泡灌洗的效果。本研究显示:观察组治疗总有效率明显高于对照组,且较对照组排痰量增多,MV和ICU住院时间明显缩短,证实纤支镜肺泡灌洗联合振动排痰治疗更有效,可加速患者康复,降低医疗成本。黎代强<sup>[20]</sup>通过对120例重症肺炎患者实施纤支镜肺泡灌洗联合振动排痰治疗,发现先行背部振动排痰有助于促进细小气道中黏稠的痰液移动至大气道,有利于纤支镜灌洗后将痰液吸出,从而提高疗效,有效率明显高于对照组(86.67%比66.67%,P<0.05)。姚剑坤<sup>[21]</sup>研究也显示,振动排痰可通过彻底清除深部气道的痰液与炎性因子,改善通气和换气功能,明显提高重症肺炎MV患者的疗效,改善预后。

综上,与单纯纤支镜肺泡灌洗比较,联合振动排痰治疗重症肺炎MV患者更为有效,有助于改善呼吸功能,减轻炎症反应,促进痰液排出,并能缩短MV及ICU住院时间,加速患者康复。但本研究未显示出联合治疗对28 d病死率的改善作用,有待开展多中心研究及扩大样本量进一步证实。

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