

# Postoperative chest physical therapy prevents respiratory complications in patients undergoing esophagectomy

Fisioterapia respiratória pós-operatória previne complicações respiratórias em pacientes submetidos à esofagectomia

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## Abstract

**Background:** Esophagectomy presents the highest rate of postoperative pulmonary complications among all types of upper abdominal surgery. The benefits of chest physical therapy in patients undergoing upper abdominal surgery have been shown by many studies; however, its specific effect in patients receiving esophagectomy has been seldom investigated. **Objectives:** This study aimed to compare the frequency of respiratory complications in patients undergoing esophagectomy receiving chest physical therapy compared to no treatment. **Methods:** 70 consecutive patients were evaluated retrospectively and allocated to two groups: control group (CG=no physical therapy; n=30) and chest physical therapy group (PTG; n=40). Patients received chest physical therapy which includes lung re-expansion and airway clearance maneuvers. They were not submitted to either noninvasive ventilation or exercises with devices that generate airways positive pressure. All patients were instructed to early mobilization. Information about pre-operative and respiratory complications were collected. Statistic analysis to compare the frequency of respiratory complications was performed by the Z test. The significance level was set to 5%. **Results:** Patients in the CG and PTG were similar in terms of age, BMI, smoking and drinking status, malignant diseases, surgical and anesthesia duration and types of esophagectomy ( $p>0.05$ ). Our results show that patients received chest physical therapy after esophagectomy had a lower frequency of respiratory complications (15% vs. 37%,  $p<0.05$ ). In addition, the PTG needed a shorter duration of antibiotic treatment and thoracic drainage as well as less re-intubation compared with the control group ( $p<0.05$ ). **Conclusions:** Our results suggest that chest physical therapy treatment reduces respiratory complications and the need for care but does not influence on hospital length of stay.

**Keywords:** esophagectomy; respiratory therapy; physical therapy; postoperative care; postoperative complications; surgery.

## Resumo

**Contextualização:** A esofagectomia apresenta a maior taxa de complicações pulmonares pós-operatórias dentre as cirurgias abdominais altas. Os benefícios da fisioterapia respiratória em pacientes submetidos à cirurgia abdominal alta convencional têm sido mostrados na literatura, porém esse efeito na esofagectomia tem sido pouco investigado. **Objetivos:** Comparar a frequência de complicações respiratórias em dois grupos de pacientes submetidos à esofagectomia, tendo um recebido fisioterapia respiratória e o outro não. **Métodos:** Setenta pacientes consecutivos (nenhuma exclusão) foram avaliados retrospectivamente e divididos em dois grupos: controle (GC=sem fisioterapia; n=30) e fisioterapia respiratória (GFT; n=40). O PTG recebeu manobras para expansão pulmonar e higiene das vias aéreas. Nenhum deles foi submetido à ventilação não-invasiva ou a exercícios com pressão positiva. Todos os pacientes foram orientados à mobilização ativa, progressiva e precoce. Foram coletadas informações sobre o perioperatório e complicações respiratórias. A frequência de complicações respiratórias entre os grupos foi analisada pelo teste z, considerando  $p<0,05$ . **Resultados:** Pacientes de ambos os grupos foram similares quanto à idade, IMC, tabagismo e etilismo, doença maligna, tempos cirúrgico e anestésico e tipos de esofagectomia ( $p>0,05$ ). Nossos resultados mostram que pacientes que receberam fisioterapia respiratória após a esofagectomia tiveram uma frequência menor de complicações respiratórias (15% vs. 37%,  $p<0,05$ ). O PTG precisou de menos tempo de antibioticoterapia e de drenagem torácica, assim como teve menos reintubação, comparado com o controle ( $p<0,05$ ). **Conclusões:** Os resultados sugerem que a fisioterapia respiratória após esofagectomia reduz as complicações respiratórias e a necessidade de cuidados clínicos, mas não reduz o tempo de hospitalização.

**Palavras-chave:** esofagectomia; terapia respiratória; fisioterapia; cuidado pós-operatório; complicações pós-operatórias; cirurgia.

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## Introduction

Postoperative pulmonary complications are common and are an important cause of perioperative morbidity<sup>1</sup>. Upper thoracic and abdominal surgeries are associated with a high frequency of respiratory morbidity and mortality<sup>2</sup>, with the risk rate for pulmonary complications following upper abdominal surgery ranging from 17% to 88%<sup>3</sup>. Many studies have assessed the efficacy of chest physical therapy in patients undergoing upper abdominal surgery and the benefits consist of reversal of atelectasis, improvement of peripheral oxygen saturation and reduction of pneumonia rates. However, most studies did not include a control group, and the benefits of chest physical therapy in these patients remain unknown<sup>4-6</sup>.

Esophagectomy presents the highest rate of postoperative pulmonary complications among all types of upper abdominal surgery, even exceeding those observed for pulmonary resection<sup>7</sup>. Patients undergoing esophagectomy have a rate of complications ranging from 30% and 64%, including aspiration, infections, respiratory failure and sepsis<sup>2,8</sup>. The increased rate of complications in esophagectomy is due to surgical manipulation in the abdominal and thoracic compartments, a longer surgical duration and neuromuscular paralysis by dissection around the recurrent nerve and airways<sup>9</sup>. There is no direct evidence of the effectiveness of chest physical therapy in the prevention or treatment of pulmonary complications after esophagectomy, as few investigations have been reported<sup>10</sup>.

The aim of the present study was to compare the frequency of respiratory complications in patients undergoing esophagectomy receiving chest physical therapy compared to a no treatment.

## Methods

### Study design

This was longitudinal, retrospective and controlled analysis of 70 consecutive patients (none excluded) undergoing esophagectomy at a university tertiary hospital referral center for abdominal surgery. Information concerning perioperative procedures and postoperative complications were gathered from patient charts. All patients having undergone esophagectomy within the previous 5 years were splitted into 2 groups: individuals who underwent to esophagectomy between April of 2005 and June of 2007, during which time no chest physical therapy was administered (control group=CG; n=30), and those who underwent to esophagectomy between July of 2007 (beginning of the hospital's postoperative chest physical therapy

attendance on the ward) and April of 2009 (chest physical therapy group=PTG; n=40). The surgical technique and perioperative care were not innovated during this period, except for the beginning of chest physical therapy services on the ward. The study design was approved by the ethics committee of the Hospital of Clinics, Universidade de São Paulo (USP), Sao Paulo, SP, Brazil, protocol number 179/05.

### Assessment of pre-operative factors

Data regarding age, gender, weight, height, clinical history and diagnostic history were drawn from patient charts. Body mass index (BMI) was then calculated. Additional information on smoking and alcoholism was also collected from patient records.

### Assessment of the type of surgery

Information of the type and duration of surgery carried out for each patient was taken from their respective surgical reports. Esophagectomy was classified according to surgical approach: transhiatal (xipho-umbilical laparotomy add left cervicotomy), transthoracic (xipho-umbilical laparotomy add left cervicotomy add thoracotomy on the right hemithorax) and thoracoscopy (xipho-umbilical laparotomy add left cervicotomy add three 2-cm thoracoscopy incisions on the right hemithorax). The duration of anesthesia was also assessed.

### Assessment of postoperative factors

Information of patient evolution, including length of stay in intensive care unit and hospital lengths of stay, time under mechanical ventilation, days of Cephalosporin antibiotic use, duration of thoracic drainage, need to return to mechanical ventilation and postoperative complications observed between hospital admission and discharge were also extracted from the patient charts.

### Assessment of postoperative respiratory complications

As used herein, the term postoperative respiratory complications (PRC) denotes the development of one or more of the following:

- atelectasis, confirmed by a radiographic image of reduced lung volume, accompanied by opacification of a pulmonary lobe or other lung area, which can also be related to a partial drop in arterial oxygen saturation<sup>11</sup>;
- pneumonia, defined as a radiologically-confirmed infiltration accompanied by body temperature above 37.7°C,

- white blood cell count exceeding 10.500/ $\mu$ L, or evidence of pathogenic organisms<sup>12</sup>;
- c) pleural effusion, appearing on the chest X-ray as a blunting of the costophrenic angle, which can include the meniscus sign when a greater volume of liquid has accumulated<sup>13</sup>.

## Chest physical therapy

Only patients in the PTG received postoperative chest physical therapy on the ward. Each chest physical therapy session lasted, on average, 20 minutes and included exercises aimed to lung re-expansion (respiratory exercises associated with maximum sustained and fractional inspiration) and airway clearance maneuvers (assisted cough and expiratory airflow techniques). All patients were instructed to get out of bed as early as possible and also received stimulus to maintain themselves to be functionality active during hospitalization. None of the patients received either noninvasive ventilation or exercises with devices that generate positive airways pressure.

## Statistical analysis

The Kolmogorov-Smirnov test was used to assess the normal distribution of the data, whereas unpaired *t*-tests, together with the *z* test, were used to compare variables between groups. The level of significance was get to a *p* value lower than 5% ( $p < 0.05$ ).

## Results

### Pre-operative findings

Both groups presented similar pre-operative anthropometric characteristics, habits and diagnoses (Table 1). Although not significant, there was a higher proportion of elderly patients (>65 years of age) in the PTG compared to the CG (27.5% vs. 20%). The surgical procedures used for the esophagectomy included transhiatal, transthoracic and thoracoscopy, and they were also similar between both groups. In addition, no difference was observed regarding surgical and anesthesia duration, length of stay in the intensive care unit, or mechanical ventilation assistance following surgery (Table 2). The PTG received, on average, 12.3 sessions over 15.2 days of hospitalization.

### Benefits of chest physical therapy in the postoperative period

Subjects in the PTG experienced a lower rate of PRC than those in the CG (15% vs. 37%;  $p < 0.05$ ) (Figure 1). The lower rate of total PRC in the PTG included a lower frequency of atelectasis (1 out 30 in the CG vs. 1 out 40 subjects in the PTG;  $p < 0.001$ ) and bronchopneumonia (3 out 30 in the CG vs. 1 out 40 subjects in the PTG;  $p = 0.05$ ) (Figure 1).

**Table 1.** Pre-operative characteristics of patients undergoing esophagectomy.

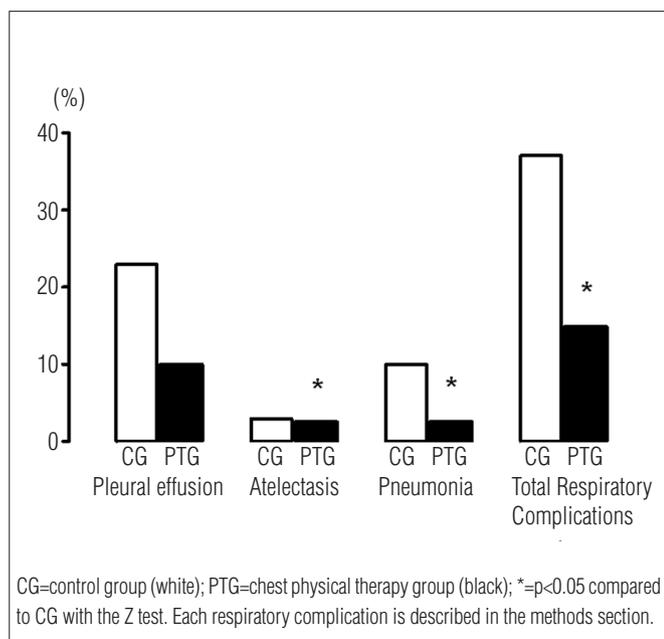
Anthropometric data	Group	Value	95% CI	<i>p</i> value
Age (years)*	CG	53.5 $\pm$ 12.5	35.0 to 76.0	0.36
	PTG	56.5 $\pm$ 14.2	26.0 to 78.0	
BMI (kg/m <sup>2</sup> )*	CG	22.3 $\pm$ 3.4	18.0 to 28.1	0.86
	PTG	22.6 $\pm$ 3.9	17.8 to 29.0	
Gender (female/male) (%)	CG	40/60		0.91
	PTG	44.5/55.5		
<b>Complicating factors</b>				
Smoking (pack years)*	CG	30 $\pm$ 21	0.0 to 66.0	0.21
	PTG	30 $\pm$ 29	0.0 to 96.4	
Smoking habit (%)	CG	76.6		0.93
	PTG	73.3		
Drinking habit (%)	CG	58.3		0.97
	PTG	55.8		
<b>Diagnosis</b>				
Cancer (%)	CG	80.0		1.00
	PTG	80.0		
Megaesophagus (%)	CG	13.3		0.32
	PTG	7.5		
Esophageal stenosis (%)	CG	6.7		0.26
	PTG	12.5		

\* Data are presented as the mean $\pm$ SD; CG=control group; PTG=chest physical therapy group; BMI=body mass index.

**Table 2.** Intra-operative and postoperative data on subjects underwent esophagectomy.

Surgical procedures	Group	Value	95% CI	p value
Transhiatal (%)	CG	76.7		0.86
	PTG	75.0		
Thoracotomy (%)	CG	13.4		0.39
	PTG	15.0		
Thoracoscopy (%)	CG	9.9		0.20
	PTG	10.0		
Surgical duration (min)*	CG	389.3±96.7		0.74
	PTG	398.6±119.7		
Anesthesia duration (min)*	CG	483.8±98.4		0.64
	PTG	496.8±125.7		
<b>Postoperative factors</b>				
ICU stay (days)†	CG	3.5	0.1 to 3.8	0.63
	PTG	4.0	0.1 to 4.5	
Time under MV (days)*	CG	1.4±2.8		0.22
	PTG	1.9±2.9		
Cephalosporin use (days)†	CG	15.3	7.8 to 26.7	0.03
	PTG	12.6 <sup>‡</sup>	5.0 to 21.0	
Drainage on RHT (days)†	CG	10.0	8.0 to 15.0	0.04
	PTG	8.0 <sup>‡</sup>	7.0 to 10.0	
Drainage on LHT (days)†	CG	9.0	6.2 to 12.0	0.94
	PTG	8.0	6.0 to 11.5	
Length of hospital stay (days)†	CG	14.0	8.0 to 24.2	0.63
	PTG	13.5	3.6 to 29.8	
Return to MV (% of patients)	CG	6.6		0.01
	PTG	2.5 <sup>‡</sup>		

Data are presented as the mean ± SD (\*) or median (†); CI=confidence interval; CG=control group; PTG=chest physical therapy group; ICU=intensive care unit; MV=mechanical ventilation; RHT=right hemithorax; LHT=left hemithorax; <sup>‡</sup>=p<0.05.



**Figure 1.** Percentage of respiratory complications in subjects underwent esophagectomy. Data are presented as a proportion of complications in each group.

Patients in the PTG received less antibiotics (third-generation Cephalosporin) than did patients from the CG (between group difference = 3 days, p<0.05). In addition, the PTG also retained the right hemithorax drainage for 2 days less than the CG (p<0.05), and they had a 50% reduction of the need to return to mechanic ventilation. However, no such difference was observed between groups regarding to both left hemithorax drainage time and hospital length of stay (Table 2).

## Discussion

The results of the present study suggest that postoperative chest physical therapy in esophagectomy patients reduces the rate of respiratory complications, the need for antibiotics, the thoracic drainage time, and the need to return to mechanical ventilation.

In the present study, the frequency of respiratory complications ranged from 15 to 37%, which is consistent with data observed in the literature<sup>10,14</sup>. A number of authors have suggested that certain factors, such as malnutrition, older age

(over 65), presence of malignancy and low performance status predispose to the development of PRC<sup>7,15,16</sup>.

The benefits of chest physical therapy for patients undergoing upper abdominal surgery have been evaluated by many studies. However, most of them aimed either to assess the preventive effects of chest physical therapy or to compare the postoperative effectiveness of different techniques, including incentive spirometry, continuous positive airway pressure ventilation, deep breathing exercises and recovery of ambulation<sup>17</sup>. In general, distinct chest physical therapy techniques have been shown to have equivalent effects to prevent postoperative respiratory complications in upper abdominal surgery. Our hospital is a referral center for abdominal surgery and receives patients presenting a high number of co-morbidities. However, in the present study, we evaluated 70 consecutive patients without any exclusion. Therefore, our results suggest that the benefits of chest physical therapy observed may occur independently of the patient's selection criteria.

The mean length of the chest physical therapy sessions was 20 minutes, and treatment for each patient was administered using a few techniques aimed to improve lung ventilation. Bronchial hygiene techniques such as assisted coughing and expiratory airflow technique were used to reduce or prevent patient's airway secretions while lung re-expansion techniques such as respiratory exercise therapy associated with maximum sustained inspiration and fractional inspiration were used to reduce the frequency of atelectasis. In addition, patients were also motivated to begin to walk as soon as possible. Positive airway pressure ventilation was not used in any patient since it is known that this technique for lung expansion is contraindicated because it can cause cervical anastomotic leak in patients undergoing esophagectomy<sup>18</sup>. In our study, the benefits obtained by patients occurred despite the fact that they have received, on average, less than 1 session per day (12.3 sessions over 15.2 days of hospitalization). The reduced number of chest physical therapy sessions can be explained by the fact that the physical therapy services in our hospital are only available during week days (i.e. 5 days/week). Therefore, we can infer that the benefits observed in our study might have been even better if the chest physical therapy sessions would be offered on a daily basis.

Although the rate of pneumonia observed in this study is lower than reported elsewhere, ranging between 20 and 30%, the reduction of this complication in the PTG is an important finding, since this pneumonia is considered an independent factor for mortality after esophagectomy<sup>8</sup>. This is because after this manipulation, the patients have worsening of swallowing and aspiration developed pneumonia. For treatment, the use of antibiotics appears to be higher in patients presenting infected airway secretion or pneumonia<sup>9</sup>. Therefore, our findings suggesting that chest physical therapy reduced antibiotic usage in patients undergoing esophagectomy are extremely relevant

and might even have repercussions for hospital costs; however, this outcome was not evaluated in our study. Despite the difficulties involved in the understanding of the mechanism by which chest physical therapy reduces the duration of antibiotic use, we can speculate that this result occurred partly as a result of improved mucociliary activity and productive coughing.

For patients undergoing esophagectomy, the use of a chest tube is indispensable for draining the liquid accumulated in the intra-pleural space during the post-operative period<sup>19</sup>; which usually occurs only in the right hemithorax. In spite of its postoperative importance, the chest tube drain limits patient mobility and causes pain, occasionally leading to hypoventilation, atelectasis or lung infections, as well as reducing cough efficiency<sup>20</sup>. Our results may suggest that chest physical therapy stimulates lung expansion and improves lung ventilation, thereby preventing or eliminating the build-up of liquid in the pleural space, meeting the drainage removal criteria (less than 100 mL in 24 hours) earlier and facilitating the removal of the drain<sup>21</sup>.

Re-intubation for respiratory failure in patients undergoing esophagectomy varies from 9% to 17% of the cases<sup>22-24</sup>. This frequency in our study has been lower (6.6%) in the control group and even lower in the PTG (2.5%), possibly due to protective effect of physical therapy intervention in this population, which had decreased significantly since the frequency of respiratory complications.

Several factors might have hampered the analysis of our results. This is a retrospective study and the group receiving chest physical therapy received it chronologically after the group not receiving this treatment. Therefore, the administration of new anesthetics or the involvement of more experienced surgeons, might, at least partially, explain the differences observed. However, we do not believe that this has occurred because both groups had similar surgical and anesthesia durations, surgical approach, and length of postoperative stays in the intensive care units.

We emphasize that, despite the short treatment of respiratory therapy offered to patients undergoing esophagectomy, the decreased frequency of respiratory complications shows the efficiency and striking indication of the standard respiratory care in this population. Nevertheless, further prospective randomized controlled trials are warranted to corroborate the results obtained in our study.

## Conclusion

Our findings suggest that chest physical therapy administered during the postoperative period reduces respiratory complications as well as can yield clinical benefits for patients undergoing esophagectomy, but without impacting on the hospital length of stay.

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