

# Original Article

## Influence of pleural drainage on postoperative pain, vital capacity and six-minute walk test after pulmonary resection\*

Influência do dreno pleural sobre a dor, capacidade vital e teste de caminhada de seis minutos em pacientes submetidos à ressecção pulmonar

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### Abstract

**Objective:** To evaluate the influence of pleural drainage on the distance covered on the six-minute walk test, pain intensity and vital capacity in patients submitted to pulmonary resection. **Methods:** Thirteen consecutive patients from the Thoracic Surgery Infirmery of *Hospital São Paulo*, Brazil, submitted to closed pleural drainage (0.5-in multiperforated chest tube) in the postoperative period following pulmonary resection (lobectomy, segmentectomy and pulmonary nodule resection) were evaluated. The decision for chest tube removal followed clinical criteria defined by the surgical team, who did not participate in the study. Vital capacity, pain intensity (using a visual analog pain scale) and the distance covered on the six-minute walk test were determined 30 min prior to and 30 min after the removal of the chest tube. The statistical analysis was performed using paired t-tests, and the level of significance was set at 0.05. **Results:** After the removal of the chest tube, the visual analog scale pain scores were significantly lower (3.46 cm vs. 1.77 cm;  $p = 0.001$ ) and the distance covered on the six-minute walk test was significantly higher (374.34 m vs. 444.62 m;  $p = 0.03$ ). Vital capacity prior to and after chest tube removal was not significantly affected (2.15 L and 2.25 L, respectively;  $p = 0.540$ ). **Conclusions:** The results of the present study suggest that the presence of a chest tube is a factor significantly associated with postoperative pain and functional limitation in patients submitted to pulmonary resection.

**Keywords:** Thoracic surgery; Exercise test; Respiratory function tests; Pain, postoperative.

### Resumo

**Objetivo:** Avaliar a influência do dreno pleural sobre a distância percorrida no teste de caminhada de seis minutos, da intensidade da dor e da capacidade vital de pacientes submetidos à ressecção pulmonar. **Métodos:** Foram avaliados treze pacientes consecutivos, internados na Enfermaria da Cirurgia de Tórax do Hospital São Paulo, submetidos à drenagem pleural fechada (dreno tubular multiperfurado de 0,5 polegada), no período pós-operatório de ressecção pulmonar (lobectomia, segmentectomia e nodulectomia). A opção pela retirada do dreno seguiu critérios clínicos definidos por médicos da equipe cirúrgica alheios ao estudo. A determinação da capacidade vital, da intensidade da dor através da escala visual analógica de dor e da distância percorrida no teste de caminhada de seis minutos foram realizadas 30 min antes da retirada do dreno e 30 min após. A análise estatística dos dados foi realizada através do teste t pareado, com nível de significância estabelecido em 0,05. **Resultados:** Após a retirada do dreno, os valores obtidos na avaliação da escala visual analógica de dor foram significativamente menores (3,46 cm vs. 1,77 cm;  $p = 0,001$ ), e a distância percorrida no teste de caminhada de seis minutos foi significativamente maior (374,34 m vs. 444,62 m;  $p = 0,03$ ). A capacidade vital antes e após a retirada do dreno não foi alterada de forma significativa (2,15 L vs. 2,25 L, respectivamente;  $p = 0,540$ ). **Conclusões:** Os resultados deste estudo sugerem que a presença do dreno pleural é um importante fator associado à dor pós-operatória e à limitação funcional em pacientes submetidos à ressecção pulmonar.

**Descritores:** Cirurgia torácica; Teste de esforço; Testes de função respiratória; Dor pós-operatória.

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## Introduction

In surgical procedures performed within the thoracic cavity, the use of intercostal tube drainage is common, especially for drainage of the pleural space. Among the various drainage techniques and strategies that can be used, the most common consists of using two chest tubes: an anterior one, positioned in the upper third of the thoracic cavity, and a posterior one, positioned in the lower third. Recent studies, however, have shown that the use of a single chest tube has some advantages, such as pain reduction and lower hospitalization costs.<sup>(1,2)</sup>

It has been suggested that intercostal tube drainage, regardless of the technique used, is a factor significantly associated with the development of postoperative pulmonary complications. The thoracic trauma resulting from the chest tube insertion would promote greater pain<sup>(3)</sup> and additional changes in postoperative respiratory mechanics.<sup>(4,5)</sup> In addition, early ambulation after surgery also seems to be impaired or delayed by the presence of a chest tube.<sup>(6)</sup>

The current literature suggests that early chest tube removal can be performed safely<sup>(7)</sup> and provides substantial patient benefits, such as reduced postoperative chest pain, reduced incidence of pulmonary complications and reduced length of hospital stay.<sup>(8-10)</sup> Early reestablishment of functional activities, such as ambulation, after chest tube removal has been shown to be one of the factors that lead to better patient recovery.<sup>(6)</sup> There are, however, few studies evaluating whether chest tube removal actually favors the performance of functional activities in the postoperative period. The effect of chest tube removal on patient-reported chest pain and on respiratory mechanics has also not been extensively studied. The objective of the present study

was to analyze the influence of chest tube removal on the distance covered on the six-minute walk test (6MWT), as well as on pain intensity and vital capacity (VC), in patients submitted to pulmonary resection.

## Methods

### Study design

This was a prospective study carried out in the Thoracic Surgery Ward of the *Hospital São Paulo*, Federal University of São Paulo. All patients aged 18 years or older who were submitted to pulmonary resection (lobectomy, segmentectomy or pulmonary nodule resection) and underwent closed pleural drainage in the postoperative period were considered for inclusion in the study. Patients who presented orthopedic, neurological or vascular changes that could affect their performance on the 6MWT, as well as those who were unable to understand the instructions for the tests proposed, were excluded from the study.

Sample size was calculated considering the distance covered on the 6MWT as the primary outcome measure. For a bidirectional alpha of 0.05 and a power of 80%, considering the standard deviation of the distance covered on the 6MWT obtained in a pilot study and a difference of 60 m as clinically significant, we inferred that a sample of 13 patients was sufficient to answer the central question of the present study.

The study was approved by the Ethics in Research Committee of the Federal University of São Paulo *Hospital São Paulo*, and written informed consent was obtained from each participant.

### Protocol

All patients were evaluated based on the 6MWT results in the preoperative period, according to the routine of the Department of Thoracic Surgery of our institution.

In the postoperative period, the decision for chest tube removal followed clinical criteria defined by the *Hospital São Paulo* thoracic surgery team, who did not participate in the study. Pain intensity, VC and the distance covered on the six-minute walk test were assessed 30 min prior to and 30 min after the removal of the chest tube.

**Table 1** – Characteristics of the patients studied (n = 13).

Gender, n (%)	
Male	9 (69)
Female	4 (31)
Type of surgery, n (%)	
Lobectomy	5 (38)
Segmentectomy	4 (31)
Pulmonary nodule resection	4 (31)
Age, years <sup>a</sup>	59.08 ± 11.36
Duration of thoracic drainage, days <sup>a</sup>	3.38 ± 0.65

<sup>a</sup>Data presented as mean and standard deviation.

Pain intensity was measured using a visual analog pain scale. This scale uses a 10-cm horizontal line whose left extremity indicates the absence of pain and whose right extremity indicates the worst pain ever experienced. Patients were instructed to draw a vertical line, crossing the horizontal line between the two extremities, in order to represent the intensity of their pain.<sup>(11)</sup> Pain intensity was assessed before the 6MWT was performed and before VC was measured.

A spirometer (model 121; Ohmeda, Boulder, CO, USA), connected to a rigid plastic mouthpiece, was used to measure VC, which was determined based on an inspiration up to total lung capacity, followed by an expiration down to residual volume. A nose clip was used to avoid air leaks through the nose of the patients. The measurements were performed a maximum of six times, until three values presenting a variation of less than 5% among them were obtained, and the highest of those three values was considered for the analysis. The patients were evaluated in a sitting position. The evaluator was responsible for preventing any type of leaks, optimizing the fitting of the mouthpiece to the lips of the patients.

The 6MWT is a simple and reproducible test of functional capacity. In the present study, the 6MWT was performed in accordance with the American Thoracic Society criteria.<sup>(12)</sup> The patients were instructed to walk at their fastest pace, without running or trotting, along a corridor (20 m in length) for 6 min. Once a minute, the physical therapist encouraged the patients by using one or two phrases: 'you are doing well' or 'maintain your pace'. The patients were advised that they could interrupt the test in order to rest and that, after resting, they should start walking again as soon as they felt ready. However, the timekeeping was not interrupted.

### Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences, version 13.0 for Windows (SPSS Inc., Chicago, IL, USA). In the descriptive analysis, means and standard deviations were used for the numerical variables, whereas frequencies and percentages were used for the categorical variables. The calculation of the flattening coefficients of the curves generated revealed that

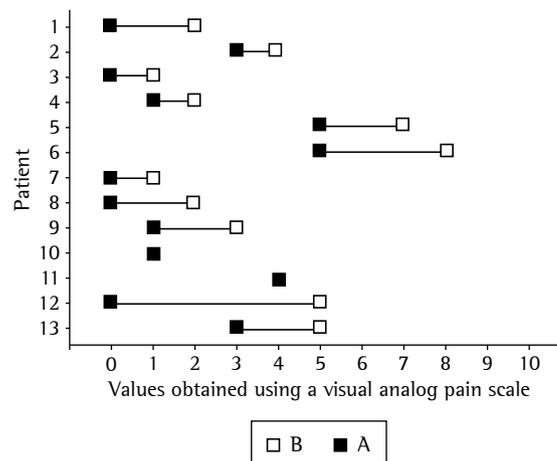
the VC data presented normal distribution, as did the data obtained using the visual analog pain scale and the data on the distance covered on the 6MWT, and should, therefore, be analyzed using parametric tests. Paired t-tests were used to compare the data obtained prior to and after the removal of the chest tube. The alpha error was set at 0.05.

### Results

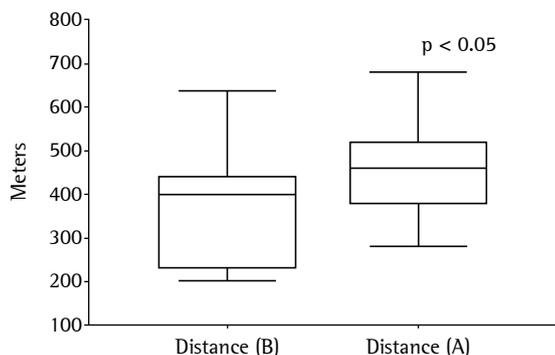
A total of 13 consecutive patients, all submitted to pulmonary resection through a posterolateral incision, were evaluated. All patients were submitted to closed pleural drainage using a 0.5-in multiperforated chest tube, which was positioned in the fifth or sixth intercostal space in the midaxillary region. All patients received opioids through an epidural catheter until postoperative day 3. Subsequently, the analgesia regimen consisted of the use of oral dipyrone or oral tramadol.

During the data collection period, none of the patients were excluded based on the study exclusion criteria. The characteristics of the patients studied are described in Table 1.

The visual analog scale pain scores were significantly lower after the removal of the chest tube (3.46 cm vs. 1.77 cm;  $p = 0.001$ ), which represents a 49.7% decrease in the pain reported by the patients (Figure 1).



**Figure 1** - Absolute pain values (using a visual analog pain scale) obtained for each patient before (B) and after (A) the removal of the chest tube.



**Figure 2** – Box plot showing the distance covered on the six-minute walk test before (B) and after (A) the removal of the chest tube.

The distance covered on the 6MWT was significantly greater after the removal of the chest tube (374.34 m vs. 444.62 m;  $p = 0.03$ ). Therefore, the mean distance covered on the 6MWT after the removal of the chest tube increased by 70.28 m (Figure 2).

The values obtained for VC were slightly higher after the removal of the chest tube, although the difference was not statistically significant (2.15 L vs. 2.25 L;  $p = 0.54$ ).

## Discussion

Through this prospective cohort study, we observed that chest tube removal decreases chest pain and improves 6MWT performance in patients submitted to pulmonary resection. Respiratory mechanics, evaluated by determining VC, were not influenced by chest tube removal.

The reduction in pain intensity after chest tube removal corroborates data reported in the literature.<sup>(2,3,10)</sup> One group of authors studied the variation in the visual analog scale pain scores obtained prior to and after the administration of analgesics.<sup>(11)</sup> The authors concluded that reductions of 33% in pain levels represent a statistically significant difference. Therefore, the 49.7% pain reduction observed after chest tube removal in the present study can be considered clinically significant. Chest pain is the principal patient complaint during the initial postoperative period. Consequently, in addition to an adequate analgesia protocol, any other strategy that can reduce postoperative chest pain

should be applied whenever possible. One such strategy is early chest tube removal.

No significant differences were found between the VC values obtained prior to chest tube removal and those obtained chest tube removal. However, we believe that the small size of the patient sample involved in the present study did not provide sufficient power for the adequate inferential evaluation of this variable. It is possible that, in studies involving larger patient samples, the tendency toward an increase in VC after chest tube removal would become a statistically significant difference. However, one group of authors studied the effect of pleural drainage on recovery of VC in the post-operative period following pulmonary resection and observed that VC was not influenced by early chest tube removal.<sup>(6)</sup>

In order to evaluate whether chest tube removal would have any influence on the functional capacity of patients submitted to pulmonary resection, we opted for using the 6MWT. This is a simple, well-standardized test that is recommended as a means of evaluating the effects of therapeutic interventions in many clinical situations.<sup>(12)</sup> In contrast to other exercise tests, the 6MWT evaluates functional capacity at submaximal levels, and is therefore considered the test that best represents the ability of patients to perform activities of daily living.<sup>(12)</sup> In our study, the distance covered on the 6MWT was found to be significantly greater after the removal of the chest tube. There was an increase of 70.28 m in relation to the values obtained prior to the removal of the chest tube, a distance considered statistically significant in the American Thoracic Society guidelines.<sup>(12)</sup> The increase in the distance covered during the test can be related to the absence of the restraint imposed by the chest tube while walking, to reduced chest pain or to psychosomatic factors, such as fear of dislodging the chest tube. Some authors suggest that early reestablishment of ambulation after surgery can reduce the incidence of postoperative pulmonary complications,<sup>(13,14)</sup> improve circulatory function and decrease the incidence of thromboembolic events.<sup>(15)</sup> In addition, ambulation can prevent the process of physical deconditioning suffered during hospitalization,<sup>(16)</sup> favoring the early return of patients to their activities of daily living after discharge and the improvement of their postoperative quality of life.

In 2001, one group of authors evaluated the effect of early chest tube removal on 6MWT performance in the postoperative period following pulmonary resection.<sup>(6)</sup> A group of patients submitted to early chest tube removal and a group of patients submitted to the traditional approach (mean duration of chest tube use, 1.5 vs. 2.8 days, respectively) were compared in terms of the distance covered on the 6MWT, applied one week after surgery. In the group in which the chest tube was removed earlier, 6MWT performance was better. The authors suggest that the fact that patients were able to leave bed and ambulate early was responsible for their better functional capacity one week after surgery. The results of the present study confirm this hypothesis, showing that the presence of a chest tube is a major limiting factor, and that the ability of patients to perform functional activities improves after its removal.

Caution should be exercised in attempting to generalize the findings of the present study, since the study protocol presents certain limitations in its design. Since the variables studied had to be evaluated prior to and after chest tube removal, it was not possible to keep the patients or the evaluator blinded as to the different conditions under which the outcomes were evaluated. Since it was not possible to randomize the order of the evaluation, it is likely that the effect of learning the 6MWT contributed to improving performance after chest tube removal. The literature does not clearly show which is the true degree of influence that the learning effect has on 6MWT performance.<sup>(12)</sup> However, we believe that, in the case of our study, the fact that the patients were familiarized with the 6MWT in the preoperative period minimized this possible influence.

The results of the present study suggest that the presence of a chest tube is a factor significantly associated with postoperative pain and functional limitation in patients submitted to pulmonary resection. Further studies are needed in order to determine whether early reestablishment of ambulation, favored by chest tube removal, is associated with reduced incidence of postoperative pulmonary complications, as well as whether this allows patients to resume their activities of daily living and positively influences quality of life after discharge.

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