Removal of chest tubes: a prospective randomized study

Göğüs tüpü çekme yöntemleri: Randomize prospektif bir çalışma

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Background: This study aims to determine which method and timing of chest tube removal is associated with a lower risk of developing recurrent pneumothorax.

Methods: This prospective study was designed to evaluate the removal method and time in 144 patients (57 females, 87 males; mean age 43.2 years; range 8 to 72 years) with chest tubes inserted for trauma and other causes. Patients were randomly assigned into two groups according to the respiratory phase of the chest tube removal. Subgroups were assigned by subdividing these groups according to whether or not suction was performed and according to whether chest tube removal occurred at 6-12 hours or 24-48 hours.

Results: Results supported that tube removal at the end-inspiration phase is more appropriate than removal at the end-expiration and no suction phases ($p<0.013$). In addition, recurrent pneumothorax was observed significantly more often in patients whose chest tubes which were removed at 6-12 hours rather than at 24-48 hours ($p<0.028$). The mean duration of hospital stay was significantly longer in patients with recurrent pneumothorax ($p<0.01$).

Conclusion: Removal of chest tubes at the end of inspiration with suction and after 24-48 hours is associated with a lower rate of recurrence of pneumothorax and a significantly shorter duration of hospital stay.

Key words: Chest tube drawing; duration of hospital stay; recurrent pneumothorax.

Amaç: Bu çalışmada, hangi göğüs tüpü çıkarma zamanı ve yönteminin daha düşük bir nüks pnömotoraks gelişme riski ile ilişkili olduğu belirlendi.

Çalışma planı: Travma ve diğer nedenlerle göğüs tüpü uygulanan 144 hastada (57 kadın, 87 erkek; ort. yaş 43.2 yıl; dağılım 8-72 yıl) göğüs tüplerinin çıkarma zamanı ve tekniğini değerlendirmek için bu prospektif çalışma tasarlandı. Hastalar göğüs tüpünün solunumun hangi fazında çıkarılacağına göre rasgele iki gruba ayrıldı. Gruplar göğüs tüpleri çıkarılırken emme uygulananlar ve uygulanmayanlar, 6-12 saat ve 24-48 saat'te göğüs tüpü çıkarılanlar olarak alt gruplara ayrıldı.

Bulgular: Sonuçlar, ekspirium sonunda ve emme uygulanmadan çıkarılan olgular ile karşılaştırıldığında, göğüs tüpünün inspirum sonunda ve emme uygulanarak çıkarılmasını desteklemektedir ($p<0.013$). Buna ek olarak, göğüs tüpleri 6-12 saatte çıkarılan hastalarda reküren pnömotoraks gelişimi, 24-48 saatte çıkarılanlara göre anlamlı derecede daha sık idi ($p<0.028$). Ortalama hastanede kalış süreleri reküren pnömotoraks gelişen hastalarda belirgin olarak daha uzundu ($p<0.01$).

Sonuç: Göğüs tüplerinin 24-48 saat sonra ve emme ile inspiryum sonunda çıkarılması, daha düşük reküren pnömotoraks gelişme oranı ve anlamlı olarak daha kısa hastanede kalış süresi ile ilişkilidir.

Anahtar sözcükler: Göğüs tüpü çekme; hastanede kalma süresi; tekrarlayan pnömotoraks.

The insertion and removal of chest tubes are interventions which require experience because of the possible complications. The drain should not usually be removed until bubbling has ceased, daily fluid drainage is minimal (<100 ml/24 h), and chest radiography demonstrates lung reinflation. The most important complication after the removal of chest tubes is a recurrence of the pneumothorax.[1] This leads to an increase in patient morbidity and longer stays in the hospital. Nevertheless, there is no consensus regarding which day or which phase of respiration the tube should be removed.[2-5] In the literature, authors suggested tube removal at both end-inspiration[6-9] and end-expiration[10,11] phases.

In addition, the optimal timing for removal has not been determined, and opinions remain divided. This study was designed to address chest tube removal methods and timing.

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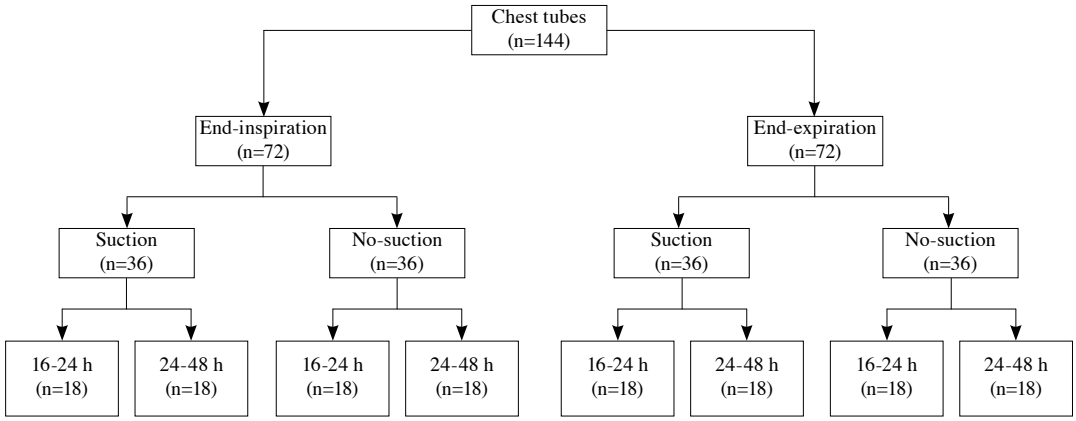

Figure 1. Flow-chart of randomization of groups.

PATIENTS AND METHODS

This prospective study of 144 patients (57 females, 87 males; mean age 43.2 years; range 8 to 72 years) with tubes randomly assigned for removal at the end of inspiration or at the end of expiration either with or without suction was conducted between January 2005 and January 2008 at the Department of Surgery, University Hospital of Yüzüncü Yıl University in Van, Turkey. Informed consent was obtained from all patients, and ethical approval was secured for the study. Tube thoracostomy indications and associated organ injuries were determined. The patients were divided into two groups according to the phase of respiration at which the chest tube would be removed. Then, these groups were divided into the following subgroups: those to whom suction was applied while removing the chest tubes, those to whom no suction was applied while removing the chest tubes, those whose chest tubes were removed at the end of six to 12 hours, and those whose chest tubes were removed at the end of 24 to 48 hours.

The flowchart of randomization and groups is listed below (Figure 1). The criteria for chest tube removal were complete reinflation or stable pneumothorax with no air leak demonstrated by radiograph along with fluid drainage of less than 200 ml/day. The same specialist and assistant performed all removals using the same method. Tubes were removed quickly with one movement while binding the "U" suture and immediately closing the thoracostomy incision with petroleum gel. Patients were evaluated by chest radiography at six and 24 hours after removal. Patients with recurrent pneumothorax were evaluated for collapse by the method described by Rhea et al.[12] Small collapses (<20%) were treated with nasal oxygen and observation while large collapses (>20%) required a tube thoracostomy. Recurrent pneumothorax development rates between the groups after the removal of the chest tube were compared using the z-test and

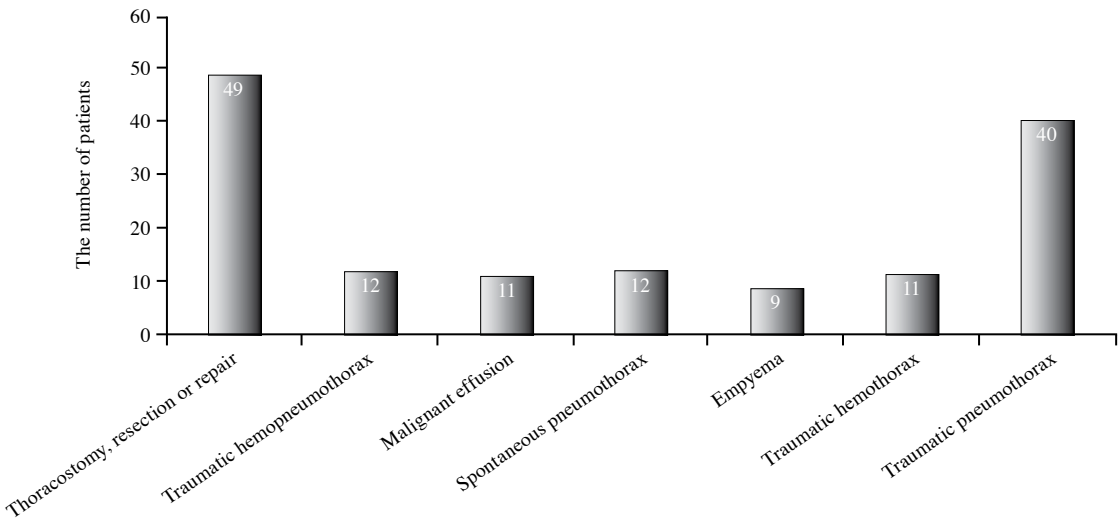

Figure 2. Indications for tube thoracostomy.

Table 1. Lung and other organ damage in cases

Intrathoracic pathology	Extrathoracic pathology
Lung parenchymal laceration	Head trauma
Bronchial vascular injury	Extremity fracture
Tracheobronchial injury	Abdomino pelvic injuries
Intercostal artery injury	Spine injury
Internal mammarian artery injury	Ovarian cancer
Cardiac injury	Breast cancer
Bullous lung	Lymphoma
Pneumonia	
Lung cancer	
Pleural tumors	
Hydatid cyst	
Bronchiectasis	
Lung abscess	

supported by the chi-square test. Comparison of mean duration of hospital stays and chest tube removal time were analyzed with the Student's t-test. Also, the relationship between pathologies in which the indication of a need for chest tube insertion and the recurrence rates after removal of the chest tube was assessed. A *p* value of <0.05 was accepted as significant. Analysis was performed using statistical SPSS for Windows version 13.0 program (SPSS Inc., Chicago, Illinois, USA).

RESULTS

A thoracostomy with resection or repair was the most frequent (34.02%) cause of chest tube insertion (Figure 2). Lung and other organ injuries associated with the pathologies for which a tube thoracostomy was indicated are presented in table 1.

Recurrent pneumothorax developed in 26 (18.05%) cases after removal with most cases (61.0%) belonging to the end-expiration group (Table 2).

The recurrent pneumothorax rate was significantly lower in the end-inspiration plus suction group compared with the end-expiration without suction group (p=0.013). This difference was especially significant in both groups for removals at six to 12 hours (p<0.016; Table 3).

Removal of chest tubes at six to 12 hours resulted in significantly more recurrent pneumothorax cases compared with removals at 24 to 48 hours (p<0.028).

The degree of collapse was smaller than 20% in 20 (76.93%) cases with recurrent pneumothorax, and treatment was to include patient observations in conjunction with oxygen therapy. The degree of collapse was greater than 20% in six (23.07%) of the cases, and a repeat tube thoracostomy was performed. No significant difference was detected between repeat thoracostomy rates in the groups, but a significantly longer length of stay was observed in patients with recurrent pneumothorax (p<0.01; Table 4).

DISCUSSION

The discussion about the optimal method for insertion[7,13] and removal[3,9] of chest tubes has not been resolved. The factors that seem to affect the rates of recurrent pneumothorax after chest tube removal are rapidity of the movement, quick closure, the degree of effort in performing Valsalva's maneuver, experienced by doctors during the procedure.[14,15] Clamping of the drain 24 hours before removal is necessary according to some authors while some believe that clamping is only beneficial in patients with a persistent air leak.[3,16-18] There is no agreement on the timing of the removal. Davis et al.[9] showed that air leak cessation of 24 hours or fluid drainage of less than 200 ml per day demonstrated safe conditions for removal with only a small risk (2.5%) for recurrence. Sharma et al.[16] reported that recurrent pneumothorax occurred in 25% of patients after removal of the tube at six hours following re-expansion in patients with spontaneous pneumothorax. In our study, removal was performed after complete resolution of the pneumothorax, and air leak cessation and fluid drainage

Table 2. Recurrent pneumothorax rates according to respiratory phase and removal times

	Recurrent pneumothorax			
	6-12 hours	24-48 hours	*Total*	
	n	n	n	%
Method				
End-inspiration (n=36)	4	2	6	33
End-inspiration + suction (n=36)	2	1	3	17
End-expiration (n=36)	8	3	11	61
End-expiration + suction (n=36)	4	2	6	33
Total	18	8	26	100

Chi-square test= 0.109, p = 0.818.

Table 3. Complete analysis results of chest tube removal methods

Method	Group 1	Group 2	Z	*p*
End-inspiration/end-inspiration + suction	6/36	3/36	1.18	0.239
End-inspiration/end-expiration	6/36	11/36	1.41	0.16
End-inspiration/end-expiration + suction	6/36	6/36	0.00	1.00
End-inspiration + suction/end-expiration	3/36	11/36	2.48	0.013
End-inspiration + suction/end-expiration + suction	3/36	6/36	1.08	0.281
End-expiration/end-expiration + suction	11/36	6/36	1.41	0.16

Chi-square test= 8.784, p = 0.118.

Table 4. Analysis of length of hospitalization and chest tube removal time along with rate of recurrent pneumothorax

	n	Mean±SD (hours)	Minimum-maximum (hours)
Length of hospitalization			
Recurrence	26	16.50[a]±1.86	12-21
No recurrence	118	9.57[b]±2.85	4-17
Total	144	10.83±3.80	4-21
Chest tube removal time			
Recurrence	26	8.12[b]±2.32	4-14
No recurrence	118	9.57[a]±2.85	4-17
Total	144	9.31±2.81	4-17

SD: Standard deviation; Different lower cases indicate different group means (p<0.01).

of less than 100 ml per day were observed. As a result of these discussions, Baumann[19] concluded that there is a need for a more optimal method and that further studies are required in response.

Some authors are in favor of removal at end-expiration or during Valsalva's maneuver, but some suggest removal at end-inspiration. In one study, the removal of chest tubes at end-inspiration was compared with end-expiration. No significant difference was seen between these two methods regarding recurrent pneumothorax.[2] Miller and Sahn[10] suggested removal during Valsalva's maneuver and at end-expiration. Coughlin and Parchinsky[14] reported the advantages of removing the tube with a brisk firm movement at end-expiration. Welch[20] suggested removal at end-inspiration while the patients were holding their breath. It is also recommended by some researchers to use continuous suction to prevent complications during removal.[3,21] On the other hand, Davis et al.[9] reported no difference in recurrent pneumothorax rates whether suction was used or not during removal.

We found that removal of the chest tubes during end-expiration without suction resulted in a significant increase in recurrent pneumothorax rates compared with removal at end-inspiration with suction (p<0.016). Recurrent pneumothorax is reported as 2-24%, and reinsertion of a chest tube as 1-6% in studies in the literature.[1,3,9,22,23] Our results were in concordance with these rates for recurrent pneumothorax (18.05%), but we performed more reinsertions (23.07%).

In this study, we evaluated recurrent pneumothorax rates after chest tube removal. As a result, this study verifies that chest tube removal at a late period (24-48 h) and during maximum inspiration and suction is related to a lower incidence of recurrent pneumothorax with a shorter length of hospital stay.

Declaration of conflicting interests

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