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Are small bore thorax catheters effective in the treatment of primary spontaneous pneumothorax?

Primer spontan pnömotoraks tedavisinde küçük çaplı toraks kateterleri etkili midir?

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Abstract

Aim: The first option in the treatment of primary spontaneous pneumothorax (PSP) is still controversial. Large bore thoracic drains (LBTD) are generally preferred by clinicians. However, the use of small-bore thorax catheters (SBTC) has increased in recent years. In our study, we aimed to compare the treatment efficacy, clinical outcomes and pain levels of small and large diameter thoracic catheters used in PSP treatment.

Methods: Patients over the age of 18 who presented with a diagnosis of PSP between August 2017 and August 2019 were included in the study. The patients were divided into two groups according to the application of small and large bore thorax drain. Demographic information, clinical results and pain levels of the groups were analyzed retrospectively. The duration of hospitalization, duration of drainage and Visual Analogue Scale (VAS) results were evaluated comparatively.

Results: 95 male and 10 female patients with a median age of 26 (22-33) were included in the study. LBTD was applied to 47 (44.8%) and SBTC was applied to 58 (55.2%) of the patients. Recurrence was observed in 6 (12.8%) of LBTD group and in 4 (6.9%) SBTC group. VAS scores, drainage time, hospital stay were significantly less in patients with small-sized drainage.

Conclusion: SBTC application is easy to apply, causes less pain, has shorter drainage time and duration of hospital stay. It is as effective as traditional thoracic drains in the treatment of PSP.

Keywords: Pneumothorax, Thoracic drain, Small bore thoracic catheter, Primary spontaneous pneumothorax

Öz

Amaç: Primer spontan pnömotoraks (PSP) tedavisinde ilk seçenek hala tartışmalıdır. Klinisyenler tarafından genellikle geniş çaplı toraks drenleri tercih edilmektedir. Fakat son yıllarda da küçük boyutlu kateterlerin kullanımı artmıştır. Çalışmamızda PSP tedavisinde kullanılan küçük ve geniş çaplı toraks kateterlerinin tedavi etkinliği, klinik sonuçları ve oluşturdukları ağrı seviyeleri karşılaştırılması amaçlandı.

Yöntemler: Ağustos 2017 ve Ağustos 2019 arasında PSP tanısıyla başvuran 18 yaş üstü hastalar çalışmaya dahil edildi. Hastalar küçük ve geniş çalı toraks dreni uygulanmasına göre iki gruba ayrıldı. Grupların demografik bilgileri, klinik sonuçları ve ağrı seviyeleri geriye dönük olarak incelendi. Hastanede yatış süresi, drenaj süresi ve Görsel Analog Skala sonuçları karşılaştırmalı olarak değerlendirildi. Elde edilen veriler istatistiksel olarak incelendi.

Bulgular: Ortanca yaşları 26 (22-33) olan 95 erkek ve 10 kadın hasta çalışmaya dahil edildi. Hastaların 47(%44,8)'ine geniş çaplı, 58(%55,2)'sine küçük çaplı drenaj uygulandı. İki grupta da başarısızlıkla sonuçlanan tedavi olmadı. Geniş çaplı drenaj uygulananların 6(%12,8)'sında, küçük çaplı drenaj uygulananların 4(%6,9)'sinde nüks izlendi. Gruplar arasında yaş, cinsiyet, hastalık yönü, sigara durumu, nüks oranı açısından istatistiksel olarak anlamlı fark saptanmadı. Görsel Analog Skala sonuçları, drenaj süresi, hastane yatış süresi küçük boyutlu drenaj uygulanan hastalarda anlamlı olarak daha az bulundu.

Sonuç: Daha az ağrı oluşturan, kolay uygulanan, daha kısa drenaj ve hastanede yatış süreleri sahip küçük çaplı toraks kateteri uygulamasının geleneksel toraks drenleri kadar PSP tedavisinde etkilidir.

Anahtar kelimeler: Pnömotoraks, Toraks dreni, Küçük çalı toraks kateteri, Primer spontan pnömotoraks

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Introduction

Pneumothorax is defined as the collection of air in the intrapleural space [1]. The spontaneous pneumothorax without any underlying lung disease is known as primary spontaneous pneumothorax (PSP). Although the etiology is still not clear, the most common cause of PSP is the rupture of pulmonary bullae and blebs [2,3]. The frequency of this disease is 18-28 / 100000 in men and 1.2-6 / 100000 in women. PSP makes up approximately 20% of hospitalizations in thoracic surgery clinics [4].

The most common symptoms are chest pain while resting, cough and dyspnea. Physical examination and chest radiography are sufficient for the diagnosis; whereas thorax computed tomography is the gold standard in diagnosis of minimal pneumothoraxes [5].

Conservative treatment is effective in minimal and asymptomatic PSPs. The main purpose for the treatment of larger and symptomatic cases is to extract the air from the intrapleural space and relieve the symptoms [6]. For this purpose, simple needle aspiration, small bore thoracic catheter (SBTC) or large bore thoracic drain (LBTD) insertion, surgical interventions by thoracoscopy or thoracotomy can be performed. Nevertheless, the initial treatment option in PSP is still unclear.

Traditionally, chest tubes have been the first treatment option for pleural conditions such as pneumothorax, pleural effusion, hemothorax and empyema. But the importance of SBTC has increased in the last 2 decades [7]. The use of SBTC has become more popular among surgeons, pulmonologists and oncologists due to its easy application with the Seldinger technique and better pain outcomes [8].

In our study, we evaluated the patients who were admitted to our clinic with the first episode of PSP and who underwent LBTD or SBTC insertion. We aimed to compare clinical outcomes in terms of pain, recurrence, drainage time and hospital stay.

Materials and methods

Patient selection

Patients over the age of 18 who were underwent SBTC and LBTD insertion due to primary spontaneous pneumothorax between August 2017 and August 2019 were included in the study. Patients under 18 years of age or who were treated conservatively for minimal pneumothorax, or diagnosed as secondary spontaneous pneumothorax, iatrogenic and traumatic pneumothorax were excluded.

Prospectively recorded demographic data (age, gender, smoking status, size of pneumothorax) and clinical features (type of drainage, visual analog scale -VAS, drain termination time, hospital stay, and recurrence rates) of the patients were analyzed retrospectively.

Pneumothorax sizes of the patients were evaluated by using Light Index [9] (% pneumothorax = 100 x [1–(lung diameter/hemithorax diameter)]) on the chest X-ray. Pneumothorax size which were 20% and below were evaluated as minimal, 20-40% as partial, 40-60% as subtotal, and 60% and above as total.

The patients who were admitted between August 2017 and August 2018 underwent LBTD (20-28 French- F) insertion. SBTC (8F) insertion was applied to patients who were admitted between August 2018 and August 2019. Patients with minimal PSP were treated conservatively (bed rest, high flow oxygen inhalation and analgesic medication).

This study was approved by Local Ethics Committee (Decision No:20l9/ll27, Date:25/09/2019). This study was carried out in accordance with the principles of the Helsinki Declaration (Version: B.10.4.ISM.4.06.68.48 / 184).

Surgical technique

Surgical procedures were performed under local anesthesia (Prilocaine HCl). To perform LBTD insertion, local anesthesia was injected to the 5th intercostal space after skin disinfection and a 2 cm skin incision was made. Following muscle and pleural dissection by a Kelly clamp, LBTD was placed into the intrapleural space. The drain was fixed to skin using silk No. 0 and LBTD was connected to the underwater seal drainage. To insert SBTC, a 3 mm incision was made after anesthesia injection into the the 3rd intercostal space, following skin disinfection. The catheter was inserted into the intrapleural space by passing through the muscle and pleura with the help of a metal cannula and fixed to the skin with No. 2/0 silk suture. The air in the intrapleural space was removed by negative aspiration with a 60 cc syringe. When the aspiration was finished, the one-way valve on the catheter tip was connected to a urine bag. Cefazolin sodium was administered to all patients before the procedure.

After the procedures, the location of the SBTC or LBTD was confirmed by Chest X-rays in all patients. For pain management, intramuscular diclofenac sodium (75 mg, 2 times a day), and paracetamol 500 mg oral tablet (3 times a day) were given to all patients after the procedure. VAS was applied to patients 4 times: Immediately after the procedure, at the 1st, 6th and 12th hours of drainage. Patients were asked to choose a number between 0-10 (0: no pain, 10: worst pain). LBTD and SBTC were terminated after 24 hours when the lung was fully expanded, and the air leak stopped. Patients were followed up with chest X-rays on the 10th day, 1st month and 3rd month after discharge.

Statistical analysis

Statistical analyses were performed by SPSS (Statistical Package for the Social Sciences Version 22.0; SPSS Inc. Chicago, IL, USA) software package. The normal distribution of the data was assessed with the Shapiro-Wilk test. Categorical data were recorded as frequency and percentage. Non-parametric values were given as median (25.-75. percentiles). The relationship between the categorical variables was examined with the Chi-square and Fisher's exact tests and the relationship between the nonparametric data and continuous variables with the Mann-Whitney U test. For all analyses, $P<0.05$ was considered statistically significant.

Results

There were 134 patient admissions to our clinic with PSP diagnosis. Twenty-nine patients with minimal PSP who were treated conservatively without surgical intervention were excluded from the study.

The median age of 95 (90.5%) male and 10 (9.5%) female patients was 26 (22-33). 85 (81%) of the patients were smoking. 56 (53.3%) of the PSPs were right sided, 49 (46.7%) were left sided. 61 (58.1%) of the patients had total, 12 (11.4%) had subtotal, 32 (30.5%) had partial pneumothorax by Light Index [9] evaluation. Recurrences were detected in 10 (9.5%) patients after discharge (Table 1).

No significant difference was found between the groups in terms of age, gender, smoking status and pneumothorax side (0.661, 0.337, 0.634, and 0.675, respectively). The size of pneumothorax which was evaluated by Light Index (9) was found to be significantly higher in patients who underwent SBTC insertion (P<0.001) (Table 1).

The median drainage time was 5 (4-6) days in the LBTD group and 3.5 (3-4.25) days in the SBCT group. The median time of hospitalization were 7 (5-8) days in the LBTD group and 3.5 (3-4.25) days in the SBCT group. Patients who underwent SBCT insertion had statistically significantly shorter catheter lengths and hospital stays (P<0.001) (Table 1). Pain severity, evaluated by VAS scores, right after the procedure, at the 1st, 6th and 12th hours were significantly lower in the SBCT group (Table 2) (P<0.001). Pneumothoraxes were treated successfully in all patients. Recurrence was detected in 4 (6.9%) patients who underwent SBTC and 6 (12.8%) patients who underwent LBTD insertions. There was no statistically significant difference between the two applications (P=0.337).

Table 1: Comparative evaluation of the LBTD and SBTC

		LBTD n:47(44.8%)	SBTC n:58(55.2%)	Total n:105	*P*-value
Age Median (25-75)		25.00 (21.00-34.00)	27.00 (22.00-32.25)	26.00 (22.00-33.00)	0.661
Gender n (%)	Male	41(87.2%)	54 (93.1%)	95 (90.5%)	0.337
	Female	6(12.8%)	4 (6.9%)	10 (%9.5)	
Smokers n (%)		39(83.0%)	46 (79.3%)	85 (81.0%)	0.634
Pneumothorax Size, n (%)	Minimal	0 (0%)	0 (0%)	0(0%)	<0.001
	Partial	30 (63.8%)	2 (3.4%)	32 (30.5%)	
	Subtotal	4 (8.5%)	8 (13.8%)	12(11.4%)	
	Total	13 (27.7%)	48 (82.8%)	61(58.1%)	
Pneumothorax side, n (%)	Left	23 (48.9%)	26 (44.8%)	49(46.7%)	0.675
	Right	24 (51.1%)	32 (55.2%)	56(53.3%)	
Drain termination (day) median (25-75)		5.00 (4.00-6.00)	3.50 (3.00-4.25)	4.00 (3.00-5.50)	<0.001
Hospital Stay (day) median (25-75)		7.00 (5.00-8.00)	3.50 (3.00-4.25)	4.00 (3.00-7.00)	<0.001
Recurrence n (%)		6 (12.8%)	4 (6.9%)	10 (9.5%)	0.337

n: number, LBTD: large bore thorax drain, SBTC: small bore thorax catheter

Table 2: Visual Analog Scale of LBTD and SBTC groups

	LBTD	SBTC	*P*-value
VAS (0th hour) median(25-75)	8.00 (7.00-8.00)	4.00 (3.00-4.00)	<0.001
VAS (1st Hour) median(25-75)	6.00 (5.00-7.00)	3.00 (2.00-3.00)	<0.001
VAS (6th hour) median(25-75)	6.00 (5.00-6.00)	2.00 (2.00-3.00)	<0.001
VAS (12th hour) median(25-75)	4.00 (4.00-5.00)	2.00 (1.00-2.00)	<0.001

LBTD: large bore thorax drain, SBTC: small bore thorax catheter, VAS: Visual Analog Scale

Discussion

The first thoracic drainage was performed 2400 years ago by Hippocrates in the treatment of empyema. In terms of size, drains are categorized as a "large bore" for those larger than 20 F and a "small bore" for those smaller than 20 F. In an *in vivo* study of Park et al., no significant difference was found according to the amount of fluid drainage between catheters 8F and above. However, they found that there was a significant difference between catheters larger and smaller than 8F [10].

British Thoracic Society guidelines suggests needle aspiration and immediate discharge after the procedure as the first treatment option. It states that needle aspiration with quick discharge decreases the length of hospital stay and health expenses [11]. However, The American College of Chest Physicians recommends hospitalization after LBTD insertion for the initial treatment [12]. There is still no consensus on the initial treatment of pneumothorax in Turkey. In our study, all patients who underwent surgical intervention were hospitalized. We found that SBTC insertion resulted in shorter hospitalization periods compared to LBTD (median: 7 days vs 3.5 days respectively). Çardak et al. [13] determined the hospitalization period of the SBTC group as 3.5 days and the LBTD group as 4.5 days in their study. They found no significant difference between the two groups for time of hospital stay. In another study, similarly, it was observed that the SBTC group had shorter time of hospital stay than LBTD group (median: 4 vs 7 days, respectively) [14].

Complications such as infection, malposition of the drain, hemorrhage, hypotension, and pulmonary edema may develop after pleural drainage [15]. In our study, no complications were observed in each size of drain application. According to the study of Tsai et al., there is a significant relationship between the size of pneumothorax and treatment failure. It stated that treatment failure increases for pneumothoraxes sized above 40% [16]. Although the median size of PSP in our study was significantly higher in the SBTC group, no treatment failure was observed in each group.

Prevention of recurrence is also another important treatment goal in pneumothorax patients. The second attack after discharge usually occurs within the first six months. In the study of Çardak et al. [13] no significant difference between two groups was observed in terms of recurrence rates. In a study published in Korea, patients who underwent SBTC insertion were discharged after the procedure and called after a week. The patients who underwent LBTD insertion were hospitalized. Although the drain termination time was shorter in LBTD group, the medical expenses were higher when compared with the SBTC group [17].

Chest tube application is associated with high pain and anxiety that may require intense analgesics or opioids [18]. Fang et al. [19] reported that patients who underwent LBTD insertion needed more analgesic than SBTC. In the study of Çardak et al. [13], after SBTC and LBTD procedures, patients' pain intensities were measured in the 1st, 4th, 12th and 24th hours. They found that pain levels were lower only in the 4th hour in the SBTC group. In addition, the authors observed more anxiety in patients during LBTD removal. Rahman et al. [20] found a relation between the drain size and the pain intensity during the drain insertion in their study. However, there was no significant difference between the drain size and pain intensity during drain removal. In our study, we observed less pain scores in all measurement times at the SBTC group.

Limitations

The limitations of our study are as follows: 1) The retrospective design; 2) Small study sample; 3) Short follow-up period. Using a scale to determine the pain levels at multiple times after the procedure and the comparative analysis of the homogenous intervention groups in terms of age, gender, smoking status, side of PSP are the strengths of our study.

Conclusions

Our study showed that SBTC usage in the treatment of PSP is more advantageous in terms of pain, tube determination time, and hospitalization time compared to LBTD. There is no difference in terms of effectiveness and recurrence rate. In addition, easy applicability, faster wound healing and better long-term cosmetic results are other advantages of SBTC.

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