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Original Article

Small Bore Thoracic Catheter Versus Chest Tube in Treatment of Primary Spontaneous Pneumothorax

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ABSTRACT

Objective: The primary treatment of primary spontaneous pneumothorax (PSP) is still controversial. The large-bore thoracic catheter has traditionally been used, but there is now a global trend toward the increased use of the small-bore thoracic catheters (SBTC). The present study aims to compare the use of SBTC and chest tube (CT) in first-line treatment of PSP.

Methods: This prospective randomized study included 90 patients diagnosed with PSP. The patients were randomly distributed into two groups. In the first group, catheter thoracostomy was applied with an 8 French thorax catheter and in the other group, a tube thoracostomy with a 28 French chest tube. The parameters used for comparison in this study were defined as pneumothorax side, pneumothorax size, pain, need of additional analgesia, malpositioning drain, duration of air leakage, duration of hospitalization, complications and recurrence.

Results: In the evaluation of pain using the Numerical Rating Scale (NRS) at 1, 4, 12 and 24 hours after the application, the mean NRS values of the SBTC patients were seen to be lower than those of the CT patients but at 1, 12 and 24 hours, the difference was not statistically significant. At the 4th hour, the difference was determined to be statistically significant (p=0.022). The duration of air leakage was 1.7±1.4 days for the SBTC group and 2.2±1.9 days for the CT group. The period of termination of the drain was 3.3±1.2 days for the SBTC group and 4.0±1.7 days for the CT group. The duration of hospitalization was 3.5±1.3 days for the SBTC group and 4.5±1.9 days for the CT group.

Conclusion: No significant difference was determined in respect of air leakage, hospital stay, failure rates or complications between the two procedures. When compared concerning postoperative pain, ease of application, patient comfort and incision scar, SBTC can be considered to be subjectively superior to CT, and can be used safely in the treatment of PSP.

INTRODUCTION

Primary spontaneous pneumothorax (PSP) is defined as a pneumothorax occurring spontaneously in a patient without any underlying lung disease. PSP most commonly arises in young, tall, lean males. The age-adjusted incidence is 7.4 to 18 per 100000 populations per year in males and 1.2 to 6 per 100000 populations per year in females.[1] There is no consensus concerning the primary treatment of PSP, although underwater-seal chest tube drainage is the most popular and recommended air evacuation technique. The large-bore thoracic catheter has traditionally been used for drainage of the thoracic cavities, but there is now a global trend toward the increased use of small-bore thoracic catheters.[2]

The present study aims to compare the use of a small-bore thoracic catheter (SBTC) and chest tube (CT) in first-line treatment of PSP concerning effectiveness, clinical outcomes and complications.

MATERIALS AND METHODS

Patient selection

Written informed consent was obtained from each patient. The study protocol was approved by the local Ethics Committee.

This prospective randomized study included 90 patients diagnosed with PSP in our clinic. Patients with no clinical or radiological findings of pulmonary disease were accepted as PSP cases. Any patients with secondary spontaneous pneumothorax or recurrence were excluded from this study.

Of the total 90 patients diagnosed with PSP, SBTC was applied to 45 and CT to 45. The patients comprised 42 male (93.4%) and three female (6.6%) patients in the CT group and of 45 (100%) male patients in the SBTC group. The mean age of the patients was 27.6±9.7 years, with a peak determined at 20–25 years. From the anamnesis, cigarette smoking was determined in 54 (60%) patients, 30 in the SBTC group and 24 in the CT group. The mean BMI of the total patient group was determined as 21.5±2.9. Complaints on admission were chest pain accompany dyspnea in 69 (76.6%) patients, dyspnea in 15 (16.6%) and severe chest pain in six (6.6%) patients.

According to the order of admission to the clinic, the patients were distributed into two groups using block randomization techniques. Block size of 4 was chosen, and in group A, catheter thoracostomy was applied with an 8 French (F) thorax catheter and in the other group (Group B), a tube thoracostomy with a 28F chest tube. It was planned to evaluate each group and to compare the results.

Surgical technique

In 45 patients, a small-bore thoracic catheter was used and in 45 patients, a 28F chest tube. Both thoracostomy procedures were applied with the patient in a semi-Fowler's position under local anesthetic (prilocaine HCl) from the 5th intercostal space on the mid-axillary line.

In the application of the SBTC, skin incision of approximately 3 mm was made and the cannula of the catheter was entered in the thorax under local anesthesia. After passing the pleura, using the cannula as a guide, it was placed in the thorax. The catheter was fixed with 2/0 silk suture and connected to underwater seal drainage.

The application of CT was also made under local anesthesia. Following a skin incision of approximately 1.5 cm, subcutaneous and fatty tissue, the muscles and the pleura were dissected using a Kelly clamp, and the drain was placed in the thorax. It was fixed with a U-suture of No. 0 silk and underwater seal drainage was applied.

To verify the positions of the catheters and drains, a PA chest x-ray was taken for all the patients after the procedures. Malpositioning of the catheter or drains was defined as those not oriented towards the apex, but horizontal or towards the diaphragm. Before the applications, prophylaxis of 1 gr cefazolin sodium was administered. After the application, all patients were routinely administered 8 mg lornoxicam x 2/day, 500 mg paracetamol x 4/day and 40 mg pantoprazole x 1/day until the day that the drain was terminated. At 1, 4, 12 and 24 hours after the application, the Numerical Rating Scale (NRS) was applied with the patients scoring pain from 0–10. Twenty-four hours after full expansion of the lung and air leakage was stopped, the drain was terminated. Follow-up x-rays were taken on the 10th day, then on 1st, 6th and 12th months.

Data collection and statistical analysis

Following the medical history and physical examination, a routine PA chest x-ray was taken. To make the intervention for pneumothorax, the base criteria taken were the patient complaints, the clinical status and expansion defect of more than 20% according to the Light Index (% pneumothorax = 100 x [1–(lung diameter/hemithorax diameter)3]) on the PA pulmonary radiograph.[3]

The parameters used for comparison in this study were defined as pneumothorax side, pneumothorax size (according to Light Index), and pain after the intervention, the need for additional analgesia, drain malpositioning, duration of air leakage, duration of hospitalization, complications and recurrence.

The statistical package of social sciences (SPSS) software (ver. 17.0 for Windows) was used for all statistical analyses. Numerical variables were stated as mean ± standard deviation (SD) or median (minimum- maximum). Categorical variables were stated as numbers and percentages. In the group comparisons, the Mann-Whitney U-test was used and in independent groups, the t-test, Friedman test, Chi-square test and Spearman correlation measurement. Maximum type 1 error was accepted as 0.05 and a value of $p<0.05$ was accepted as statistically significant.

RESULTS

Pneumothorax was on the right side in 51 (56.6%) patients and on the left side in 39 (43.3%) patients. According to the Light Index criteria, the mean size of the pneumothorax was calculated as 57.5%±22.7% (21%–93%). The size of the pneumothorax, according to the application, was calculated as 49.7%±24.2% in the SBTC patients and 65.4%±18.6% in the CT patients. According to the clinical presentation and demographics, groups were found to be homogeneous (Table 1).

Malpositioning was seen in two (4.4%) patients in the SBTC group and 5 (26.6%) in the CT group. The difference between the groups was not statistically significant

Table 1. Clinical characteristics of PSP patients treated with the SBTC and the CT

	SBTC (n=45)	CT (n=45)	p
Age (years)	24.2±7.1	30.9±11.0	0.059
Major symptoms			
Chest pain	3	3	0.885
Dyspnea	6	9	
Pain + Dyspnea	36	33	
Size of PTX (%)	49.7±24.2	65.4±18.6	0.056

CT: Chest tube; PTX: Pneumothorax; SBTC: Small-bore thoracic catheter.

(p=0.32). There was no need for repositioning of the drain or catheter in any patient since the lungs were all fully expanded in chest x-rays.

In the evaluation of pain using the NRS at 1, 4, 12 and 24 hours after the application, the mean NRS values of the SBTC patients were seen to be lower than those of the CT patients but at 1, 12 and 24 hours, the difference was not statistically significant (p=0.274, 0.094 and 0.082, respectively). At the 4th hour, the difference was determined to be statistically significant (p=0.022). There was a significant reduction from the 1st to the 24th hour in both application groups (p=0.004 and 0.013, respectively). There was no requirement for additional analgesia in any patient (Table 2).

The duration of air leakage was 1.9±1.7 days in the whole study group: 1.7±1.4 days for the SBTC group and 2.2±1.9 days for the CT group. The time for termination of the drain was 3.7±1.5 days for the whole group: 3.3±1.2 days for the SBTC group and 4.0±1.7 days for the CT group. The duration of hospitalization was determined as 4.0±1.7 days for the whole group: 3.5±1.3 days for the SBTC group and 4.5±1.9 days for the CT group. Despite these slight differences in favor of the SBTC group, the divergence did not reach the significance level (Table 3).

Table 2. Comparison of NSR in PSP patients treated with the SBTC and the CT

Groups		N	Mean	p
NSR 1st hour	SBTC	45	3.73	0.274*
	CT	45	4.60	
NSR 4th hour	SBTC	45	3.00	0.022*
	CT	45	4.73	
NSR 12th hour	SBTC	45	2.40	0.094**
	CT	45	3.93	
NSR 24th hour	SBTC	45	2.20	0.082**
	CT	45	3.47	

*Student t-test; **Mann-Whitney U test. NRS: Numerical rating scale; CT: Chest tube; SBTC: Small-bore thoracic catheter; PSP: primary spontaneous pneumothorax.

Table 3. Comparison of air leakage, drain termination and hospital stay in PSP patients treated with the SBTC and the CT

		N	Mean (days)	p*
Air leakage	SBTC	45	1.70	0.414
	CT	45	2.20	
Drain termination	SBTC	45	3.33	0.235
	CT	45	4.07	
Hospital stay	SBTC	45	3.53	0.173
	CT	45	4.53	

*2-tailed values; Mann-Whitney U test was used. CT: Chest tube; SBTC: Small-bore thoracic catheter; PSP: Primary spontaneous pneumothorax.

No additional treatment was applied after air drainage. In groups, no air leakage and/or expansion defect longer than seven days was detected. No mortality or major complications (hemorrhage, empyema/infection, lung laceration, re-expansion edema) were seen in either group during the application or follow-up period. At the end of the one-year follow-up, a hypertrophic scar was observed in the application site of all the patients in the CT group.

DISCUSSION

The primary treatment choice for PSP is still controversial. In the British Thoracic Society (BTS) guidelines, the first-line treatment in PSP is recommended as simple aspiration, and success rates have been reported to be similar to those of CT.[4] Other national or consensus guidelines recommend either needle aspiration or small-bore chest catheter placement.[5] However, in 2001, the American College of Chest Physicians (ACCP) reported that the first treatment choice for patients with PSP should be chest drain with underwater-seal or Heimlich valve.[6] Previous studies have shown that tube thoracostomy has been more widespread in practice.[7] In a study by Mendis et al.,[8] tube thoracostomy was found to be the first choice of surgeons at the rate of 27%, despite their national guidelines accepted simple aspiration as the primary treatment choice.

Although there is no accepted guideline in our country, Turkey, for the treatment of pneumothorax, tube thoracostomy has been recommended as the primary treatment in previous studies.[9,10] The ACCP recommends the application of a standard 16-22F chest drain or a small-bore catheter (≤14F) and the BTS in the Pleural Procedures Guide recommends the placement of a small-bore chest catheter for pneumothorax.[11] In literature, it has been reported that, generally, a small-bore chest catheter is sufficient in pneumothorax treatment.[12–15] Despite many studies in literature and treatment guides, a survey study in the Czech Republic reported that 75% of the chest surgeons would apply tube thoracostomy to patients with PSP, and 85% of those would prefer to use a 20–24F drain.[16] In another study in Sweden, the general preference was reported to be a 16–22F chest drain.[17] These studies show that the preference of chest surgeons is a large bore drain. As there is limited information available on the efficacy and morbidity of small-bore chest drains, chest surgeons tend to prefer the application of traditional methods.[18]

Drainage made with a chest drain has associated complications, such as pain, pleural infection, malpositioning, hemorrhage, hypotension,[19] and pulmonary edema, due to pulmonary re-expansion.[20] Recurrent pneumothorax, which occurs following termination of the chest drain, is a significant complication. In a study by Palesty, it was reported that after drain removal, recurrent pneumothorax developed in 10.9% of cases and the drain was re-applied to 2% of patients.[21] In the present study, when CT was being

terminated, the drain was removed at the end of forced inspiration, but no special maneuver was made when terminating SBTC. In addition, it was observed that for the patients, termination of CT was stressful and painful, but these subjective complaints were not reported by the patients during the termination of SBTC. No complications or failures were observed in either group. A statistically significant decrease was seen in the NRS from the 1st hour to the 24th hour. At the 4th hour, as there was a statistically significant difference between the two groups in respect to the NRS values, this showed that the SBTC was a less painful procedure in the early stage. Other advantages of SBTC as a technique are that it is more comfortable than CT and the application is easier. The relatively reduced malpositioning in SBTC is thought to be due to the use of the catheter cannula as a guide. As the incision for SBTC is smaller and fixation is made with finer sutures, rapid wound healing and in the long-term and less scar tissue formation is achieved.

The majority of recurrent cases of spontaneous pneumothorax occur within the first six months.[22] In the current study, recurrence developed within the first month in two patients in the CT group. No recurrence was seen in the SBTC group during the 12-month follow-up period. No statistically significant difference was determined between the two groups in respect to recurrence.

In a prospective study by Delius et al.[23] of 36 patients with spontaneous pneumothorax (primary and secondary pneumothorax together), the success rate of the small-bore catheter was reported as 53%. In a retrospective study by Aplin, the small-bore catheter was applied to 117 patients with spontaneous pneumothorax and a success rate of 72% was reported.[24] In a study by Liu et al.,[25] a retrospective comparison was made of chest drain (n=52) and small-bore catheter (n=50), and no significant difference was attained between the two groups in respect of the duration of hospital stay. In the same study, the success rate of the small-bore catheter was found to be 70%.

Our study revealed no significant difference between 8F chest catheter and 28F chest drain in terms of duration of air leakage, drain use, or hospital stay. In this study, the main limitation was the long term follow up of the patients. The recurrence rates on the long term follow up will show more accurate findings. In conclusion, no significant difference was determined in respect to air leakage, hospital stay, failure rates or complications between the two procedures. When compared concerning postoperative pain, ease of application, patient comfort and incision scar, SBTC can be considered to be subjectively superior to CT and can be used safely in the treatment of primary spontaneous pneumothorax. However, for more definitive evidence, there is a need for further more comprehensive studies with larger patient cohorts.

Informed Consent

Prospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: M.E.Ç.; Design: K.B.Ö.; Supervision: R.D.; Fundings: R.D.; Materials: A.Ö.; Data: K.B.Ö.; Analysis: K.B.Ö.; Literature search: E.E.C., R.S.E.; Writing: K.B.Ö., M.E.Ç.; Critical revision: E.E.C.

Conflict of Interest

None declared.

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Primer Spontan Pnömotoraks Tedavisinde Küçük Çaplı Toraks Katateri İle Toraks Dreni Uygulamasının Karşılaştırılması

Amaç: Primer spontan pnömotoraks primer tedavisi halen tartışmalıdır. Standart tedavi yaklaşımında geniş çaplı taraks drenleri kullanılmakla birlikte günümüzde global küçük çaplı toraks kateteri uygulaması yaygınlaşmaktadır. Çalışmamızda, primer spontan pnömotoraks ilk basamak tedavisinde küçük çaplı toraks kateteri (KÇTK) ile toraks dreni (TD) uygulamasının karşılaştırılması amaçlanmaktadır.

Gereç ve Yöntem: Primer spontan pnömotoraks tanılı 90 olgu ileriye yönelik ve randomize olarak değerlendirmeye alındı. Olgular randomize olarak iki gruba ayrıldı. Bir gruba 8 french toraks kateteri, diğer gruba ise 28 french toraks dreni uygulandı. Her iki grup değerlendirilerek sonuçları kaydedildi. Değerlendirme kriterleri, pnömotoraks tarafı, pnömotoraks miktarı, ağrı, ek analjezi ihtiyacı, kateter ve dren malpozisyonu, hava kaçağı süresi, hastanede yatış süresi, komplikasyonları ve nüks idi.

Bulgular: Ağrı için işlemi takiben 1., 4., 12. ve 24. saatlerde sayısal değerlendirme ölçeği (SDÖ) kullanılarak kaydedildi. Olguların 1., 12. ve 24. saatlerde kaydedilen ortalama SDÖ değerleri küçük çaplı toraks kateteri uygulananlarda daha düşük olarak izlendi fakat istatistiksel olarak anlamlı bulunmadı (p=0.274, 0.094 ve 0.082). Fakat dördüncü saatte yapılan ölçümde istatistiksel olarak anlamlı değerler kaydedildi (0.022). Hava kaçağı süresi KÇTK uygulanan olgularda 1.7±1.4 gün iken, TD uygulanan olgularda 2.2±1.9 gün olarak kaydedildi. Dren sonlandırma süresi KÇTK grubunda 3.3±1.2 gün ve TD grubunda 4.0±1.7 gün saptandı. Hastanede yatış süreleri ise KÇTK grubunda 3.5±1.3 gün iken, TD grubunda 4.5±1.9 idi.

Sonuç: Her iki prosedürün karşılaştırılmasında, hava kaçağı süresi, hastanede yatış süresi, işlem başarısızlık oranları ve komplikasyonlar açısından istatistiksel anlamlı farklılık izlenmedi. İşlem sonrası ağrı, işlemin uygulama kolaylığı, hasta konforu, insizyon skarı gibi özellikleri açısından KÇTK subjektif olarak daha avantajlı ve primer spontan pnömotoraks tedavisinde güvenle kullanılabilen bir yöntem olarak değerlendirildi.

Anahtar Sözcükler: Primer spontan pnömotoraks; toraks dreni; toraks katateri.