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Original article

Ambulatory treatment of persistent air leaks using a portable chest drainage system: Preliminary results

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A B S T R A C T

Introduction: Persistent air leaks (PAL) is the most frequent post-operative complication in Thoracic Surgery, leading to a longer hospital stay and an increase in patient morbidity. We present a prospective study conducted in the Dr. Josep Trueta University Hospital in Gerona, involving a portable chest drainage system (PCDS) connected to a pleural drainage which allowed air leaks to be treated ambulatorily. Our aim is to demonstrate that by using this system hospital stay is reduced without increasing post-operative morbidity, and improves the quality of life of the patient.

Material and methods: The Thoracic Surgery Department of Gerona Hospital collected the data on 33 patients with PAL in the post-surgical period and who were treated ambulatorily with a PCDS. Post-operative complications were recorded, along with the mean days of ambulatory treatment with the PCDS and the hospital days saved.

Results: The mean hospital stay of the 33 patients was 7.03 days. The mean number of days that the 33 patients were treated ambulatorily with the PCDS was 9.33 days. It was calculated that there was a saving of 308 hospital days.

The ambulatory treatment of PAL did not increase post-operative morbidity.

Conclusions: The clinical results and the management of the PCDS support the treatment of this problem in patients who do not have any other causes to remain in hospital. The study shows a saving in a considerable number of hospital days stay, with no increase in patient morbidity. All the patients preferred this system to hospital admission.

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Tratamiento ambulatorio de las fugas aéreas persistentes mediante un sistema de drenaje torácico autónomo (SDTA): resultados preliminares

Palabras clave:
Fuga aérea persistente
Sistema de drenaje torácico autónomo

RESUMEN

Introducción: La fuga aérea persistente (FAP) es la complicación más frecuente en el postoperatorio de Cirugía Torácica, conllevando un aumento de la estancia hospitalaria y de la morbilidad del paciente. Presentamos un estudio prospectivo realizado en el Hospital Universitario Dr. Josep Trueta de Girona centrado en un sistema de drenaje torácico autónomo (SDTA) conectado a un drenaje pleural que permite tratar ambulatoriamente la fuga aérea. Nuestro objetivo es demostrar que mediante este sistema se permite reducir la estancia hospitalaria sin aumentar la morbilidad postoperatoria, mejorando la calidad de vida del paciente.

Material y métodos: En el Servicio de Cirugía Torácica del Hospital de Girona se recogieron 33 pacientes con FAP en el postoperatorio y fueron tratados ambulatoriamente con un SDTA. Se recogieron las complicaciones postoperatorias, la media de días del tratamiento ambulatorio con el SDTA y las estancias hospitalarias ahorradas.

Resultados: La estancia media hospitalaria de los 33 pacientes fue de 7,03 días. La media de días que los 33 pacientes fueron tratados ambulatoriamente con el SDTA fue de 9,33 días. Se calculó un ahorro de 308 estancias hospitalarias.

El tratamiento ambulatorio de la FAP no aumentó la morbilidad postoperatoria.

Conclusiones: Los resultados clínicos y de gestión del SDTA avalan el tratamiento ambulatorio de este problema en pacientes que no tengan otras causas de ingreso hospitalario. El estudio demostró ahorrar un número considerable de estancias hospitalarias, sin aumentar la morbilidad de los pacientes. Todos ellos prefirieron este sistema versus el ingreso hospitalario.

Introduction

Persistent air leak (PAL) is the most frequent postoperative complication in Thoracic Surgery, occurring in 1%-10% of all pulmonary resections.[1-4] The presence of this complication implies an increase in the admission period, health costs, and morbidity of the patient.[1,2,5]

Here we present a prospective study performed in the Thoracic Surgery Department of the Dr Josep Trueta University Hospital of Gerona, during the period between January 2007 and October 2008, in which 243 patients were surgically operated on with procedures likely to lead to air leaks. Of these, 33 patients had PAL and were discharged from the hospital with a pleural drain connected to portable chest drainage system (PCDS).

The purpose of this study is to demonstrate that managing PAL in an outpatient program through a pleural drain connected to a PCDS allows for minimising complications in the treatment of air leaks, thus reducing mean hospital admission period and obtaining a high level of comfort for the patient.

Materials and methods

In the Dr Josep Trueta University Hospital of Gerona, during the period between January 2007 and October 2008, 937 patients were operated on, 243 of which were susceptible to suffering air leaks (we excluded pneumonectomies and other surgical procedures with preservation of the pulmonary parenchyma and bronchial tree). Of these, 33 patients had PAL following surgery and were treated with a PCDS in an outpatient setting.

The following information was collected on all 33 patients: age, sex, tobacco consumption, medical history, presence of COPD, reason for the initial surgical procedure, histology and clinical TNM of all neoplasias, FEV_1, surgical technique used, use of suture machines, number of postoperative drains, use of fibrin glues, date of the surgery, date of discharge from the hospital, date of placement and removal of the pleural drain, and hospital and outpatient complications.

We calculated the total mean duration of hospital stay and the mean for each different type of operation, the total of hospital stays avoided, and the subtotal for each procedure. We measured the level of patient comfort through a patient questionnaire.

We performed all statistical analyses using G-Stat 2.0® statistical software (GlaxoSmithKline Department of Biometrics, Madrid, Spain).

All 33 patients were discharged with a PCDS that provided an endothoracic aspiration pressure of –20 cm of water. All patients returned twice a week for hospital checkups until the drain was removed.

Inclusion criteria for the study were: patients recently operated on for pulmonary resections through a thoracotomy and with PAL for over 5 days and with no other reasons

Figure – Portable Chest Drainage System (PCDS).

for hospital admission, patients operated on using videothoracoscopy (VATS) with PAL 48 h after the surgical procedure and with no other criteria for admission, and patients with secondary spontaneous pneumothorax and at high surgical risk with PAL for more than 5 days.

The day the drain was removed, a questionnaire regarding patient comfort was taken, comparing hospital versus home stays using the PCDS.

The PCDS is a portable chest drainage system that is made up of a liquid/air collection system with a watertight seal and an aspiration unit, along with an electronic system that has a double energy source (12 V batteries and 220 V current), able to use either of the two. An aspiration pump is available for each type of current, and an automatic system recharges the batteries. Aspiration pressure is less than –20 cm of water under any conditions, allowing for patient mobility with continued aspiration. (Patent number: 1064821 U/U 200700276 (0) 09/02/2007, Victor Carranza Samaniego) (Figure).

Results

Of the 243 patients surgically operated on and susceptible to air leaks, Table 1 describes all procedures performed.

The incidence of PAL during the study period was 13.5% (23) for pulmonary resections, 19.5% (9) for pneumothorax, and 3.7% (1) for sympathectomies.

Table 1 – Surgical procedures performed

Type of surgical procedure	No of procedures
Segmentectomy for BC	19
Lobectomy for BC	98
Lobectomy with bronchoplasty for BC	2
Lobectomy with decortication for TBC	1
Lobectomy for aspergiloma	1
Segmentectomy for M1 lung	32
Segmentectomy for SPN	9
Segmentectomy with VATS for M1 lung	6
Lobectomy for M1 lung	2
VATS pneumothorax	42
Pneumothorax by thoracotomy	4
VATS sympathectomy	27

BC indicates bronchogenic carcinoma; SPN, solitary pulmonary nodule.

Table 2 – Associated comorbidity

Pathological background	Number of patients (percentage)
Smoker	26 (79)
Chronic obstructive disease	14 (42)
2 or more pathological histories	19 (57.6)

Of the 33 patients that had PAL as a complication (13.5% of all patients operated on), 90.9% (30) were male.

Patient mean age was 56.36 years (range: 17-83).

All medical histories of the patients are described in Table 2. We found no statistically significant differences between the presence of risk factors and increased duration of air leaks ($P>.05$)

Of all surgical procedures that led to PAL, 67% (22) were for bronchogenic carcinoma (19 lobectomies, 2 bilobectomies, and 1 segmentectomy); 3% (1) were for M1 lung (segmentectomy); 27% (9) were for pneumothorax (bullectomy and pleurosclerosis were performed using VATS in 8 patients, and pleurosclerosis was performed using talc through the pleural drain in one patient, due to the high surgical risk), and 3% (1) were for hyperhydrosis (sympathectomy using VATS).

The histology of all primitive lung tumours and the clinical TNM results are detailed in Table 3 and Table 4, respectively.

The distribution of FEV_1 values for all patients that underwent a pulmonary resection is reflected in Table 5. We observed a statistically significant relationship ($P=.048$) between a lower value of FEV_1 and increased duration of PAL.

Suture machines were used in all 23 pulmonary resections (100%).

In 95.6% of pulmonary resections (22), 2 Argylle® pleural drains were kept (Tyco Healthcare Group Lp, Kendall Healthcare, New York, USA) (28F and 32F), with 2 19f siliconated drains kept in one case (4.3%). A pleural drain was kept in all patients operated on for pneumothorax except one where two were kept. A bilateral pleural catheter (8F)

Table 3 – Tumour histology

Histology of primary tumours	No. of tumours (percentage)
Adenocarcinoma	7 (31.8)
Squamous carcinoma	7 (31.8)
Large cell undifferentiated carcinoma	5 (22.7)
Carcinoid tumour	2 (9.1)
Bronchoalveolar adenocarcinoma	1 (4.5)

Table 4 – Clinical staging of primary tumours

Clinical TNM	No. of patients (percentage)
T1NO	4 (18.2)
T2NO	16 (72.7)
T3NO	1 (4.5)
T4NO	1 (4.5)

Table 5 – Respiratory function tests

FEV_1, %	No. of patients (percentage)
50-69	9 (39.1)
70-99	22 (52.2)
>99	2 (8.7)

was kept in the patient that underwent a sympathectomy by VATS.

In 13% of pulmonary resections (3), only one type of fibrin glue was used, whereas more than one type were used in 26.1% (6). Fibrin glues were not used in any VATS procedures.

We registered 4 complications that were established during the outpatient treatment period with PCDS: two epyemas and two residual chambers, and only the 2 epyemas required hospital readmission. We observed 2 complications derived from the PCDS itself: one battery failure and one accidental removal of the thoracic drain. Neither case required hospital readmission.

The mean hospital stay in all 33 patients was 7.03 days (range: 2-15). According to the type of procedure, the mean stay was 7.47 days (range: 5-15) in complicated pulmonary resections, 6.44 days (range: 2-14) in complicated pneumothorax, and 2 days in complicated sympathectomies. All 33 patients remained connected to the PCDS in an outpatient setting for pleural drainage a mean of 9.33 days (range: 3-22). The mean was 9.21 days (range: 4-16) for pulmonary resections, 10.22 days (range: 3-22) for pneumothorax, and 4 days for sympathectomy. We calculated that the hospital admissions avoided for all 33 patients was 308 stays: 212 stays for resection surgeries, 92 stays for pneumothorax surgeries, and 4 stays for sympathectomy.

Regarding the level of patient satisfaction as measured by the survey, 100% of patients (33) preferred outpatient care of PAL with the PCDS versus hospital admission, as they considered the system to be easy to learn and use.

Discussion

We consider PAL to be those air leaks that last longer than the established mean length of time following each type of procedure, and in our case, these were those cases that lasted more than 5 days for resection surgeries, more than 2 days for pneumothorax surgery using VATS, and more than 1 day for sympathectomies using VATS. PAL is one of the most common complications in Thoracic Surgery, occurring after an estimated 1%-10% of all pulmonary resections.[1-4] In our study, the incidence of PAL was 13.5% (23) of all complicated pulmonary resections, 19.6% (9) of all complicated pneumothorax, and 3.7% (1) for complicated sympathectomies.

The presence of this complication means an increase in the duration of hospital stay, health costs, and morbidity of the patient.[1,2]

Postoperative air leaks are due to alveolar disruption, which can occur as a result of an inadequate closing of the parenchyma during surgery, or due to postoperative reopening (bronchopleural fistula).[1-3] In patients with healthy lungs, elevation of the diaphragm near the resection and adhesion of the remaining pulmonary parenchyma to the parietal pleura help avoid air leaks.[1,5] Certain aspects of lung condition (inflammation, emphysematous parenchyma) favour the prolongation of air leaks.[1,2,6] In 32 patients from our study (96.9%), PAL was due to parenchymal disruption during the surgery, which appeared during the first minutes following the procedure. 42% of patients studied (14) had COPD, with pulmonary parenchymas that favoured this disruption. The PAL in the patient with secondary pneumothorax (who received pleurosclerosis using talc through the pleural drain) was attributed to spontaneous and persistent rupture of a bulla.

Four different types of air leaks occur.[1,4] Continuous air leaks are the most uncommon, which persist during the entire respiratory cycle, and are typical of patients with mechanical ventilation or large bronchopleural fistulas.[1,4,7] Inspiratory air leaks are also uncommon, and only present themselves during inspiration. This type of air leak is almost exclusively found in patients on mechanical ventilation. The third type of air leak is expiratory, occurring during expiration, and increases with forced expiration. This type of air leak is typical following resection surgeries and those for bronchial fistulas. The fourth type of air leak occurs only during forced expiration, and is not present during normal inspiration and expiration. This type of leak also tends to occur following pulmonary resections. 99% of air leaks are expiratory or forced expiratory.[1,4]

Risk factors for PAL are sex (male) and the presence of COPD.[1,2] In our study, 90.9% of patients were male (30) and 42% (14) had COPD. We observed no statistically significant relationship between these two risk factors and a higher number of days with a pleural drain. Other risk factors include tissue hypoxia, malnutrition, and reduced serum albumin levels.[1] None of our patients had any of these factors.

Regarding prognostic factors for PAL during the surgical procedure, poor control of the parenchyma around fissures and/or damage to the parenchyma during manipulation of the lungs are aspects that have been shown to favour the appearance of air leaks.[1,2] Intraoperative techniques exist for preventing PAL. Some authors propose inducing pharmacological paralysis of the diaphragm during the surgery (which can be prolonged up to 48 hours postoperatively), which would contribute to elevating the ipsilateral hemidiaphragm of the surgical resection in order to avoid the formation of pleural chambers.[1,5] Some studies of statistical significance have shown that the creation of a pneumoperitoneum through the injection of transdiaphragmatic air during superior lobectomies and bilobectomies can prevent PAL by reducing the pleural space.[1,5] We did not apply any of these techniques in any of our patients. Other studies show that PAL could be avoided by bordering incomplete fissures using suture machines.[1,3] In our patients, suture machines were used in 32 cases (97%) for pulmonary resections and for finishing incomplete fissures. Lastly, various sealants and fibrin glues have been used, which also appear to reduce the appearance of leaks.[1,8,9] Only one type of fibrin glue was used in 13% of cases (3), and two in 26.1% of cases (6).

With regard to PAL in the postoperative period, some studies support keeping the pleural drain in continuous aspiration from the moment surgery ends.[1] Other authors report that no significant differences exist in terms of morbidity/mortality and hospital stays between patients with endothoracic pleural aspiration and those without. Nevertheless, the lack of aspiration does increase the number of postoperative chambers. PAL can be halted by changing the pleural drain to an area of the pleural cavity opposite to the site of the leak.[1] In the case of small leaks, the tube can be clamped and the resulting pneumothorax can be considered.[1,4] One hundred per cent of our study patients (33) received continuous aspiration in the pleural drain. Ineffective procedures have been described in the literature,[1] such as the introduction of pleurosclerotic agents (autologous blood, talc, and tetracyclines) through the pleural drain or by VATS.[1,10,11] In our study, pleurosclerosis was used in only 9 patients (27.3%), those that underwent pneumothorax surgery. Reoperations are infrequent in PAL patients (<0.05%) and are usually for closing bronchial disruptions or bronchopleural fistulas by VATS or thoracotomy.[1,5] In our study, no patients required such a procedure.

To date, outpatient treatment of pleural chambers and PAL has been based on the connection of the pleural drain to a Heimlich valve.[1,4] Recently, electronic devices have appeared on the market (Digivent® and Thopaz® [Medela Holding AG, Baar, Switzerland]), which allow for controlling the pleural space by applying a predetermined endothoracic pressure and measuring the flow of air leaks in any situation.[12] A prospective, consecutive and comparative study performed by José M Meier et al[12] objectively compared digital devices (Thopaz® and Digivent®) with pleur-Evac® (non-digital system, Teleflex Medical, Madrid, Spain) showing the advantages of early removal of the drain. This study concluded that the digital system and continuous measurements of air leaks reduced the number of days until removal of the drain, as well as the duration of hospital stays. However, this study did not reflect the experience with outpatient treatment of air leaks using these electronic devices.

All 33 patients were discharged early from the hospital, avoiding complications derived from hospital stay (nosocomial infections, vein thrombosis, and confusional syndromes).[13] We observed a minimal number of postoperative complications, and only 2 of these were attributable to outpatient management with the PCDS (system battery failure and accidental removal of the thoracic drain), neither of which required hospital readmission. All patients manifested a high level of satisfaction and easily learned to operate the system.

Conclusions

PAL is a common postoperative complication in Thoracic Surgery. It implies increased morbidity, hospital stay, and health costs for the patient. Clinical results and those from the management of PCDS endorse an outpatient approach to this problem, this being a good alternative for treating patients that have no other cause for hospital admission. This study has shown a considerable reduction in hospital stays, without implying increased patient morbidity. All patients considered the system to be easy to learn and use, preferring this system to hospital admission.

Conflict of interest

The authors affirm that they have no conflicts of interest.

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