Our Experience Using the Heimlich Valve and the Aseptic Space

Heimlich Valf ve Aseptik Boşlukla İlgili Deneyimlerimiz

Muammer Cumhur Sivrikoz,[1] Egemen Döner,[1] Cumhur Murat Tulay[2]

[1] *Department Of Thoracic Surgery, Eskişehir Osmangazi University, Eskişehir, Turkey*

[2] *Department Of Thoracic Surgery, Şanlıurfa Training And Research Hospital, Şanlıurfa, Turkey*

ABSTRACT

Aim: Air leak is the most common complication incurring after pulmonary resection. In this report, we have aimed to discuss our usage of the Heimlich valve and the application of aseptic space after lung operations.

Materials and Methods: Patients with prolonged or persistent air leakage, operated at the Thoracic Surgery Department of Eskişehir Osmangazi University School of Medicine, between March 2005 and March 2010, were recruited for the study. While Heimlich valve was used on 20 patients because of persistent air leakage, 27 patients were discharged from the hospital with an aseptic space, without Heimlich valve attachment.

Results: The mean transient time of Heimlich valve application was 8.4 (4-15) days. The mean removal time of the valve was 26.95 (7-120) days. In the group with aseptic space, chest tubes were taken out in 9 to 12 days (mean 10.65). No empyema occurred in either group.

Conclusion: In patients with prolonged or persistent air leakage, evaluation of postoperative parenchymal recovery is of importance for the timing and the choice of treatment. We think that the use of aseptic space in patients without parenchymal leakage and placement of Heimlich valves in those with ongoing parenchymal leakages will be of benefit.

Keywords: Heimlich valve, aseptic space, lung, chest tube

ÖZET

Amaç: Hava kaçağı, akciğer rezeksiyonları sonrası en sık görülen komplikasyondur. Bu yazıda, akciğer cerrahisi sonrası aseptik boşluk ile ilgili deneyimimizi ve Heimlich valf kullanımımızı tartışmayı amaçladık.

Gereç ve Yöntem: Çalışmaya, Eskişehir Osmangazi Üniversitesi Tıp Fakültesi Göğüs Cerrahisi Anabilim Dalında Mart 2005 ile Mayıs 2010 yılları arasında ameliyat edilen, uzamış ve persistan hava kaçağı olan hastalar alındı. Yirmi hastaya Heimlich valf uygulandı, 27 hasta ise Heimlich valf olmaksızın aseptik boşluk ile taburcu edildi.

Sonuçlar: Heimlich valfe ortalama geçiş zamanı 8,4 (4-15) gündür. Valf'in ortalama sonlandırma zamanı 26,95 (7-120) gündür. Aseptik boşluk gurubunda göğüs tüpü ortalama 10,65 (9-12) günde sonlandırıldı. İki gurupta da ampiyem oluşmadı.

Tartışma: Uzamış veya persistan hava kaçağı olan hastalarda postoperatif parankimal iyileşmenin değerlendirilmesi, tedavinin zamanlaması ve seçimi açısından önemlidir. Parankim kaçağı olmayan hastalarda aseptik boşluk uygulamasının, parankim kaçağı devam eden hastalarda ise Heimlich valf uygulamasının faydalı olduğunu düşünüyoruz.

Anahtar kelimeler: Heimlich valf, aseptik boşluk, akciğer, göğüs tüpü

INTRODUCTION

Prolonged air leakage is a common complication experienced after pulmonary surgery. Factors influencing the prolongation of air leakage and the treatments to be offered for prolonged air leakage change on an individual patient basis. Certain procedures used during surgery to eliminate air leakage might not be sufficient to prevent prolonged air leakage after surgery.[1] In this article we discuss the procedures for deciding on leaving an aseptic space for terminating postoperative chest tubes and the results of Heimlich valve placement in patients developing prolonged air leakages.

Alındığı tarih: 21 Aralık 2011; **Revizyon sonrası alınma:** 23 Ocak 2012; **Kabul tarihi:** 18 Şubat 2012

Yazışma adresi (Address for correspondence): Muammer Cumhur Sivrikoz, Eskişehir Osmangazi Üniversitesi Tıp Fakültesi Göğüs Cerrahi AD. Meşelik Kampüsü Eskişehir; *E-posta:* mcumhurs@hotmail.com

Solunum 2012;14(2):73–78 doi: 10.5505/solunum.2012.04764

Solunum Dergisi'ne www.solunum.org.tr adresinden ulaşabilirsiniz.

MATERIAL AND METHODS

The study recruited patients with prolonged and persistent air leakage after operation at the Thoracic Surgery Department of Eskişehir Osmangazi University School of Medicine between March 2005 and March 2010. All patients underwent routine tests before surgery. The patients to be operated were evaluated on the basis of their history, physical examination, routine laboratory tests, pulmonary function tests, arterial blood gas measurements, chest X-rays, computerised tomography (CT) of thorax. Also positron emission tomographic scans, whole body bone scans, magnetic resonance imaging, and lung ventilation–perfusion scans were used when necessary.

As a routine procedure, all patients were provided with lung expansion at the end of the operation. Thorax was closed by inserting two chest tubes; one apically and the other basally. During the postoperative period, pleural negative pressure aspiration was applied to the patients. At the beginning, for the patients with severe emphysema the pressure applied was below 10 cmH_2O and for those without emphysema was above 10 cmH_2O. During clinical follow-up, the level of pleural negative pressure aspiration was revised based on the clinical adherence of the patient, presence or absence of chest pain and the status of the air leakage as found necessary. The level of pleural negative pressure aspiration was never higher than 20 cmH_2O.[1]

As a routine procedure, the chest tube placed to the basal part of the hemithorax was removed when the air leakage stopped and when the daily drainage was below 100 ml. The chest tube at the apex was removed when air leakage stopped and minimal oscillation was identified and after total lung expansion was confirmed on chest X-rays.

If the chest tube cannot be retrieved after the seventh postoperative day due to the presence of air leakage, this clinical condition is called prolonged air leakage.[1,2] Although a subgroup of our patients had prolonged air leakage, they were identified to have total lung expansion on chest X-rays. The chest tubes of such patients were clamped and a new chest X-ray was obtained 3-4 hours after clamping. The chest tubes were removed in patients who did not demonstrate lung collapse in the control X-rays after clamping.

Patients having air leakage after the seventh postoperative day and showing collapse on their chest X-rays were asked to make a deep inspiration and strain while holding that breath. If the patients had minimal air leakage during this practice, we thought that the parenchyma had recovered and that the existing leak resulted from the bulging of the lung and clamped the tube. In the chest X-ray obtained after clamping, if the collapse line did not increase and if the clinical condition was stable, we accepted the residual pneumothorax space at that site as an aseptic space and discontinued the chest tube. If the air leakage increased during deep breath straining and continued for a long while, we decided that the leak was of parenchymal origin and that parenchymal healing was not yet complete. We considered this group of patients as having persistent air leakage. In patients in whom persistent air leakage was considered, we initiated Heimlich valve placement. After the placement of Heimlich valve, if the patient was clinically stable, if there was no increase in the collapse in control chest X-rays and if the Heimlich valve was well functioning, we discharged these patients and asked them to come for weekly outpatient follow-up visits.

During routine weekly follow-up visits, we obtained chest X-rays, performed air leakage control examinations and checked whether the Heimlich valve was effectively functioning or not. During the follow-up visits, when the air leakage stopped, when the pleural space resolved or when total expansion was achieved, we discontinued the chest tube of the patient. In patients in whom the air leakage had stopped, yet the pleural space has not resolved and total expansion could not be established, we thought that parenchymal healing was complete and the chest tube was discontinued together with the aseptic space **(Figure 1)**.

RESULTS

Of the 867 patients operated in our department between March 2005 and March 2010 with various diagnoses, 47 (%5.5) developed prolonged air leakage as a complication. Twenty seven of these were discharged with aseptic spaces and 20 were placed with Heimlich valves.

The patient group discharged with aseptic spaces, consisted of 18 male and 9 female patients with a mean age of 52.4 (32-79) years. The average size of the apical collapse was calculated as 3.1 cm (2-6.5) in these patients. The chest tubes of the patients were removed on an average of 10.65 (9-12) days. In the follow-up visits performed after the discharge, the aseptic space was seen to have decreased in size in time. There was no empyema in this patient group **(Figure 2, 3)**.

In the patient group with Heimlich valves, there were 14 men and 6 women with a mean age of 56.2 (27-85) years. The average size of the apical collapse was calculated as 2.8 (1-5.5) cm. Time to the placement of Heimlich valve was 8.4 (4-15) days on average. In this group of patients with Heimlich valves, 3 had volume reduction surgery, 1 had bulla resection, 4 had lobectomy, 2 had segmentectomy, 6 had metastasectomy, 2 had cystotomy-capitonage and 1 had decortication operations. Moreover, one patient had tube thoracostomy due to empyema and then had Heimlich valve placed. In this group of patients the time to removal of the chest tube was 26.9 (7-120) days on average. The patients placed with Heimlich valves did not develop empyema **(Figure 4, 5; Table I)**.

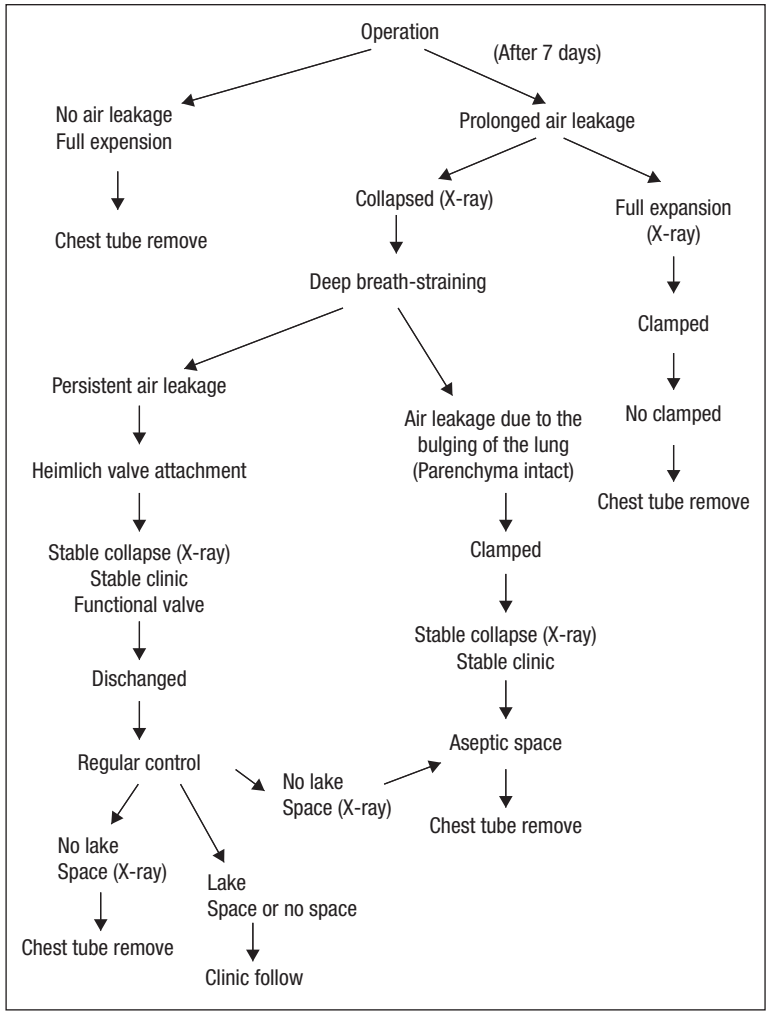

Figure 1. Algorithm of aseptic space and Heimlich valve attachment

DISCUSSION

Heimlich valve is a one-way valve with a mechanism allowing for the exit of air from the chest tube while preventing its entry in. Through this mechanism, it establishes negative aspiration within the pleural space while stabilizing the pleural space it contributes to the expansion of the lung.[2]

In the literature, there are reports about follow-ups on outpatient basis for patients attached with Heimlich valves. Preferably, these patients should not have any additional health problems. Patients with primary spontaneous pneumothorax would be the most ideal candidates for follow-up on outpatient basis after Heimlich valve placement. Most of such patients are young and they have normal respiratory reserves and they do not have coexisting problems. Mercier et al. reported complications in one of the 169 patients placed with Heimlich valves.[3] Cannon et al. treated 88% of the patients in their series without the need for hospitalization.[4] If patients have additional problems, these should definitely be solved prior to sending them home after Heimlich valve placement.[5] Likewise, for patients planned to be placed with Heimlich valves, if conditions at home do not allow for a good care, if there is excessive pain, severe pneumothorax and significant air leakage, if the patient has tension pneumothorax or hemothorax during the initial evaluation, then these patients should preferably be hospitalized and treated.[5,6]

The second group which will be a good candidate for Heimlich valve placement is secondary pneumothorax patients. This patient group is more heterogeneous and depending on the underlying disease they might have emphysema, interstitial lung disease and suppurative lung disease. It is recommended that these patients should be hospitalized and treated. Patients with limited respiratory reserves should definitely be hospitalized.[5,6]

With the condition that clinical safety and patient satisfaction is not hindered, following-up patients placed with Heimlich valve on outpatient basis brings about economical benefits. Cannon et al. made a comparison of costs for hospitalization versus outpatient follow-up and concluded that hospitalization was 5-times more expensive, and that outpatient follow-up minimized several factors like laboratory tests, radiology, medications, respiratory therapy

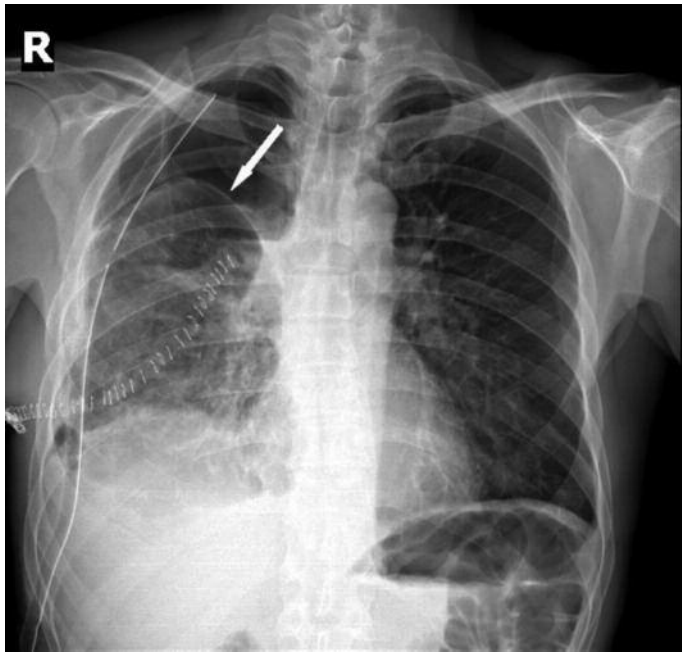

Figure 2. Chest X-ray before aseptic space. The patients have no parenchymal leaks, choosing the pathway of aseptic space. White arrow shows visceral pleural surface.

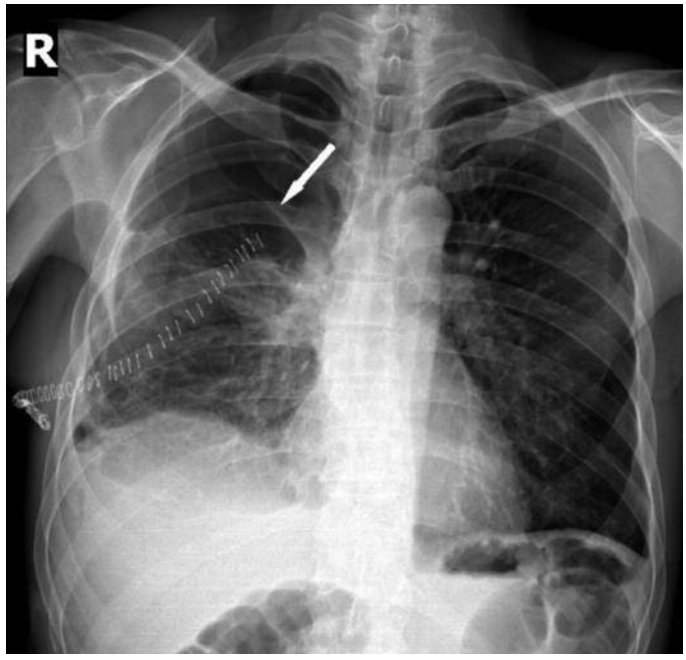

Figure 3. Aseptic space after the removing chest tube in chest X-Ry. White arrow shows visceral pleural surface.

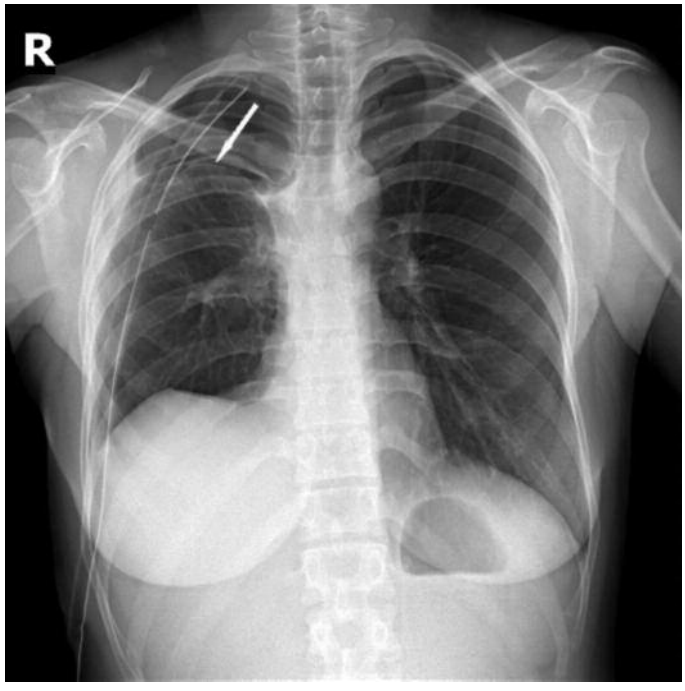

Figure 4. Chest X-ray before the attachment Heimlich valve. White arrow shows visceral pleural surface.

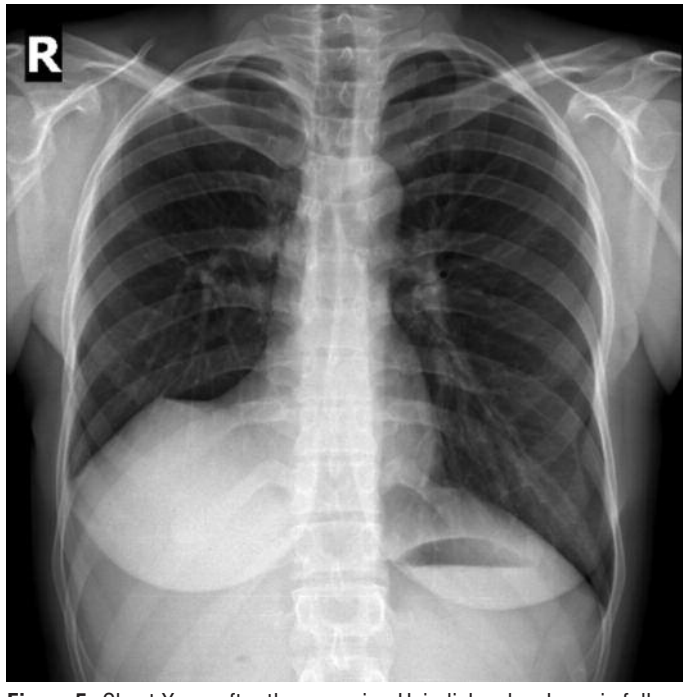

Figure 5. Chest X-ray after the removing Heimlich valve. Lung is fully expanded in chest X-ray.

and food provided by the hospital.[4] In a study by Ponn et al. based on the patients followed-up as outpatients, there was a gain of 1263 days.[6]

Heimlich valve patients followed-up as outpatients mostly have pneumothorax. Today, the numbers of pulmonary operations are on the rise. Prolonged air leakage is a common complication for pulmonary surgery with impacts on the treatment and discharge of the patient. In addition to air leakage, these patients experience difficulties with the expansion of the lung and space problems. McKenna at al.

Table I. Demographic values of Heimlich valve attachment group

Operation	Age	Sex	Space Measurement (cm)	Transient Time of Heimlich valve (Day)	The Ending Time of Heimlich valve (Day)
Volume reduction	31	E	2	4	9
Lobectomy	58	E	5	7	18
Volume reduction	71	E	2,5	8	120
Cystotomy-capitonage	60	E	4	11	12
Lobectomy	50	K	1,7	5	11
Metastasectomy	54	K	2	11	11
Bullectomy	85	E	2,5	8	7
Lobectomy	52	K	5,5	7	7
Cystotomy-capitonage	27	K	3	7	75
Lobectomy	48	E	4	11	15
Metastasectomy	46	K	2,5	7	15
Metastasectomy	61	E	3	11	23
Volume reduction	34	E	3	7	47
Decortication	63	E	2	8	10
Metastasectomy	67	K	2,5	8	9
Tube thoracostomy	53	E	3	9	50
Metastasectomy	77	E	1,5	15	28
Metastasectomy	70	E	1	9	38
Segmentectomy	56	E	3	5	20
Segmentectomy	62	E	2	10	8
Mean value	**56,2**		**2,8**	**8,4**	**26,95**

reported that in patients with postoperative air leakage, placement of Heimlich valve safely reduced the duration of hospital stay. Following volume reduction surgery, 25 (24%) out of 107 patients were discharged with Heimlich valves after 9.1 days on average.[7-10] Forty percent of these patients had moderate degree air leak and the size of the apical space was measured as 1.9 cm.[1-7] Except for one patient, all patients were successfully treated (96%) and their chest tubes were removed 7.9 (2-24) days after discharge on average.[7] Rice and Kirby reported that out of 197 patients who had undergone pulmonary resection surgery, 35 (15.2%) had prolonged air leakage after the seventh postoperative day and were placed with Heimlich valves. Chest tubes of 32 patients were discontinued one week after the placement of Heimlich valve. The chest tubes of the remaining three patients were reported to have been retrieved at the end of two weeks.[8]

Patient groups of McKenna and Rice-Kirby[8] are homogenous groups including volume reduction surgery and pulmonary resection patients. When compared with these groups, our patients were more heterogeneous as regards the surgical procedures covered. However, the conditions observed after surgery were generally similar and in essence it related to air leakage and insufficient lung expansion. Different researchers share similar views about the timing of the air leakage (2, 6-8 days). McKenna at al[7] converted to Heimlich valve after 9.1 (7-10) days while Rice and Kirby[8] had a mean

follow-up of 7 days before Heimlich valve placement and discharge of their patients.[7,8] In our patients time to Heimlich valve placement was 8.4 (4-15) days on average. Limited number of patients in our group had the Heimlich valve placed before 7 or after 11 days. The decision to place Heimlich valve earlier was based on the status of the lung parenchyma during surgery and the presence of massive air leakage postoperatively. On the other hand, the reason for delaying the placement of Heimlich valve was to take into consideration the possibility of aseptic space in certain patients.

In our study, the timing of the Heimlich valve placement was based on the possibility of discharging the patient with an aseptic space and lead to a difference in results when compared to other studies in the literature. In our series, 47 (5.5%) of 867 patients developed prolonged or persistent air leakage as a complication. Twenty seven of these patients were discharged with aseptic spaces and 20 were placed with Heimlich valves. When patients had lung expansion problems on chest X-rays but did not have leaks during deep-breath straining, we regarded them as aseptic space candidates; the chest tubes of such patients were discontinued on 10.6 (9-12) days on average with aseptic spaces. In the series recorded in the literature and also in our series, the time to placement of Heimlich valve was 7-10 days. Thus in carefully-selected patient groups it would be possible to discontinue the chest tubes around the same time period by leaving aseptic spaces. At this point, we are aware of the risk that patients with aseptic spaces might develop empyema. In our series, patients having aseptic spaces did not develop empyema. We think that this relates to careful selection of the patient group without parenchymal leakages, as well as accurate timing of allowing for aseptic spaces as has been pointed above.

Heimlich valve placement has been seen to contribute significantly to patient recovery. McKenna et al. had discontinued the chest tubes of the patients attached with Heimlich valves on 7.9 (2-24) days on average.[7] Rice and Kirby stopped the use of chest tubes one week after the placement of Heimlich valve in 32 patients, the three remaining patients had their chest tubes discontinued after two weeks.[8] In our series, the average time to discontinue the chest tubes in patients with Heimlich valves was calculated as 26.95 (7-120) days.

Without any doubt, Heimlich valve placement cuts the treatment costs. However, we must emphasize that, although we can follow-up the patient on an outpatient basis by placing a Heimlich valve, thereby, significantly reducing the hospital costs, the treatment process of this patient is not complete and for service providers the costs still accrue due to the outpatient follow-up. On the other hand, with careful patient selection, if aseptic space is to be allowed, the treatment process can be concluded faster, and as the outpatient follow-up will get shorter, this means further reduction of related costs for service providers.

In conclusion, prolonged air leakage incurred after pulmonary surgery is an important complication in several dimensions. In patients with prolonged or persistent air leakages, evaluation of postoperative parenchymal recovery is of importance for the timing and the choice of treatment. We think that in patients without parenchymal leakages the use of aseptic space and in those with ongoing parenchymal leakages the placement of Heimlich valves will be of benefit.

REFERENCES

1. Singhal S, Ferraris VA, Bridges CR, Clough ER, Mitchell JD, Fernando HC, et al. Management of alveolar air leaks after pulmonary resection. Ann Thorac Surg 2010;89:1327-1335.
2. Cerfolio RJ, Bass CS, Pask AH, Katholi CR. Predictors and treatment of persistent air leaks. Ann Thorac Surg 2002;73:1727-1730.
3. Pagé A, Cossette R, Dontigny L, Lévy R, Mercier C, Pelletier LC, et al. Spontaneous pneumothorax: outpatient management with intercostal tube drainage. Can Med Assoc J 1975;112:707-709.
4. Cannon WB, Mark JB, Jamplis RW. Pneumothorax: a therapeutic update. Am J Surg 1981;142:26-29.
5. Baumann MH, Noppen M. Pneumothorax. Respirology 2004;9:157-164.
6. Ponn RB, Silverman HJ, Federico JA. Outpatient Chest Tube Management. Ann Thorac Surg 1997;64:1437-1440.
7. McKenna RJ Jr, Fischel RJ, Brenner M, Gelb AF. Use of the Heimlich valve to shorten hospital stay after lung reduction surgery for emphysema. Ann Thorac Surg 1996;61:1115-1157.
8. Rice TW, Kirby TTJ. Prolonged air leak. Chest Surg Clin N Am 1992; 2:803-811.