

Autologous Blood Patch Pleurodesis: A Reliable Treatment Option For Prolonged Air Leakage in Children

Otolog Kan Yaması Plörodezisi: Çocuklarda Uzun Süreli Hava Kaçağı İçin Güvenilir Bir Tedavi Seçeneği

Mujdem Nur AZILI^{1,2}, Dogun GUNEY^{1,2}, Gokhan DEMIRTAS³, Suleyman Arif BOSTANCI¹,
Elif Emel ERTEN¹, Ahmet ERTURK¹, Can Ihsan OZTORUN^{1,2}, Sabri DEMIR¹, Emrah SENEL^{1,2}

¹Department of Pediatric Surgery, Ankara City Hospital, Ankara, Turkey

²Department of Pediatric Surgery, Yıldırım Beyazıt University, Ankara, Turkey

³Department of Pediatric Urology, Ankara City Hospital, Ankara, Turkey

ABSTRACT

Objective: Persistent air leaks remain one of the most complications that delay chest tube removal and prolonged hospitalization. In literature, there are limited but favorable results about autologous blood patch pleurodesis (ABPP) for prolonged air leaks (PAL). We aimed to describe our experiences with ABPP for PAL regarding its effectiveness and reliability in children.

Material and Methods: A retrospective single-center study was performed on patients under 18 years of age with PAL. PAL was defined as the presence of alveolar-pleural fistulas lasting longer than 5 days. The etiological causes including previous thoracic surgery, thoracic trauma, and spontaneous pneumothorax of PAL were included. The study took into account patients from January 1, 2016, to December 1, 2021. Autologous blood patch pleurodesis (ABPP) was performed through a pre-existing chest tube. 1-2 cc/kg of fresh whole blood that was taken from a peripheral vein and instilled through the existing chest tube on day 1. The procedure was repeated on days 2 and 4 if the air leak persisted with a maximum limit of three. During the follow-up period, complications of the procedure were evaluated. Complete success was considered as resolving air leaks.

Results: Of 11 children, males were more common (n=7, 63.9%). The mean age of children who underwent ABPP for PAL was 13.4±2.1 years (IQR 10-17). The mean number of repeating procedures was 1.8 ranging from 1 to 3 applications. In our study group, thoracic procedures secondary to spontaneous pneumothorax were the most common etiologic cause. Most of the patients had PAL during forced expiration only (n=6, 54.5%), and the mean number of ABPP applications was found 1.7 in this group. But the patients having continuous PAL required 3.1 applications for improvement (mean value). Complete recovery was possible in six cases after the first application (54.5%). PAL improved in all cases after repeating ABPP procedures (100% healing). We had seen no complications in terms of respiratory distress due to the application of ABPP or infection.

Conclusion: We report about our experiences of autologous blood patch pleurodesis (ABPP) in children as an alternative treatment option for PAL. ABPP is an easily applicable therapy with high effectiveness and being away from complications and, the use of ABPP for PAL was successful in all patients of our series.

Key Words: Air leak, Autologous blood patch, Children



0000-0002-5137-7209: AZILI MN
0000-0001-7168-2123: GUNEY D
0000-0003-0787-2330: DEMIRTAS G
0000-0002-7512-3895: BOSTANCI SA
0000-0002-3666-295X: ERTEN EE
0000-0002-8156-5665: ERTURK A
0000-0002-5408-2772: OZTORUN CI
0000-0003-4720-912X: DEMIR S
0000-0002-0383-4559: SENEL E

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Correspondence Address / Yazışma Adresi:

Mujdem Nur AZILI
Department of Pediatric Surgery, Ankara City Hospital, Ankara, Turkey
E-posta: drmujdemazili@yahoo.com

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ÖZ

Amaç: İsrarcı hava kaçakları, göğüs tüpü çekilmesini geciktiren ve uzun süreli hastanede yatışa neden olan sık komplikasyonlardan biridir. Literatürde uzun süreli hava kaçakları (UHK) için otolog kan yaması plörodesisi (OKYP) yapılması hakkında sınırlı ancak olumlu deneyimler mevcuttur. Çocuklarda etkinliği ve güvenilirliği konusunda OKYP'nin UHK için uygulanması konusunda deneyimlerimizi paylaşmayı amaçladık.

Gereç ve Yöntemler: UHK'li 18 yaş altı hastalarda geriye dönük tek merkezli bir çalışma yapılmıştır. UHK, 5 günden uzun süren alveolar-plevral fistüllerin varlığı olarak tanımlandı. Geçirilmiş göğüs cerrahisi, göğüs travması ve UHK 'nin spontan pnömotoraksa gibi etiyolojik nedenleri dahil edildi. Çalışmaya 1 Ocak 2016'dan 1 Aralık 2021'e kadar olan hastalar dahil edildi. Otolog kan yaması plöredezi (OKYP) önceden var olan bir göğüs tüpü aracılığıyla gerçekleştirildi. 1. günde periferik venden alınan 1-2 cc/kg taze tam kan mevcut göğüs tüpünden verildi. Hava kaçağının devam etme durumunda işlem 2. ve 4. günlerde tekrarlandı. Kaçak devam etse de maksimum üç uygulama hedeflendi. Takip süresi boyunca işlem ilişkili komplikasyonlar değerlendirildi. Tam başarı, hava kaçaklarının giderilmesi olarak kabul edildi.

Bulgular: Erkek çocukların daha sık olduğu toplam 11 hasta değerlendirildi (n=7, %63.9). UHK için OKYP uygulanan çocukların yaş ortalaması 13.4±2.1 yıldır (IQR 10-17). Ortalama tekrarlanan prosedür sayısı, 1 ila 3 uygulama arasında değişmekle beraber 1.8 saptandı. Çalışma grubumuzda en sık etiyolojik nedeni spontan pnömotoraksa ikincil yapılan torasik girişimlerdi. Altı olguda ilk uygulamadan sonra (%54.5) tam iyileşme mümkün oldu ve tüm olgularda OKYP prosedürleri tekrarlandıktan sonra UHK düzeldi (%100 iyileşme). OKYP'e bağlı herhangi bir komplikasyon saptanmadı.

Sonuç: Çocuklarda PAL için alternatif tedavi seçeneği olan otolog kan yaması plörodesisi (ABPP) ile ilgili deneyimlerimizi paylaşmak istiyoruz. ABPP, etkinliği yüksek, komplikasyonlardan uzak, kolay uygulanabilir bir tedavi olup, serimizin tüm hastalarında PAL için ABPP kullanımı başarılı olmuştur.

Anahtar Sözcükler: Hava kaçağı, Otolog kan yaması, Çocuk

INTRODUCTION

An alveolar-pleural fistula can be defined as pathological communication between the alveoli and the pleural space. Although pneumothorax is a common clinical presentation, it may cause air bubbling in a patient who had already had a chest tube. If the air leak persists, it may interfere with the lung expansion and can lead to serious respiratory distress (1). The most common etiologic causes of air leaks are spontaneous pneumothorax, chest trauma, and lung infection (2). Air leaks persisting beyond 5 days are termed prolonged air leaks (PAL) and associated with high morbidity and prolonged hospitalization (3,4). Until today, surgical treatment has been accepted as the gold standard. Besides, PAL is one of the most common complications after thoracic surgery (5). Thus, a new surgical procedure may be problematic after recent thoracic surgery or where surgery is contraindicated. For this reason, an appropriate approach should be planned according to the underlying pathology.

To date, chemical pleurodesis (CP) using sclerosant agents was the preferred treatment option. Although the success rates were reported between 60 and 90 percent, malignant pleural effusion is the most commonly accepted indication for CP. Because there are rare but serious complications related to the instilled sclerosant agents, especially talc and doxycycline. Thus, CP is sometimes used for nonmalignant pleural effusions. Nowadays, autologous blood patch pleurodesis (ABPP) is defined as an alternative treatment option for PAL. The technique is well-tolerated and easily applicable as well as having a high success rate. In addition, the relatively low recurrence rates (0.4-2.3%) in ABPP should be taken into account, as compared to the recurrence rates of tetracycline or talc pleurodesis (6-8). But there is no consensus for the main principles of ABPP

in the pediatric age group. This study aimed to evaluate our preliminary results of ABPP for PAL in children.

MATERIAL and METHODS

This is a retrospective single-center study that was performed in patients under 18 years of age with prolonged air leakage. PAL was defined as the presence of alveolar-pleural fistulas lasting longer than 5 days. The etiological causes of PAL were recorded including previous thoracic surgery due to spontaneous pneumothorax and lung biopsy, thoracic trauma, etc. The study took into account patients from January 1, 2016, to December 1, 2021. Thirteen patients were evaluated for PAL, and 11 patients who met the criteria were included in the study. Autologous blood patch pleurodesis (ABPP) was performed through a pre-existing chest tube. 1-2 cc/kg of fresh whole blood that was taken from a peripheral vein was immediately instilled through the chest drain to avoid clotting in the syringe. The tube was clamped for three hours by making sure that all amount of blood drained to the chest cavity. No anticoagulant agent was added. If the fistula persisted, the procedure was repeated in 24 hours (2nd instillation) and 48 hours (3rd instillation) after the previous application if necessary. A maximum limit of three applications was planned. All patients were monitored with pulse/oximetry for a possible respiratory compromise. Following three hours, the chest drain was placed to water seal. But in the presence of respiratory distress, placing the chest tube to negative pleural pressure suction was planned. The follow-up was done with chest X-rays and clinical signs. The decision not to continue ABPP was a collapsed lung accompanying a persistent air leak. Air leak classification was used to identify the degree of air leakage. The number of ABPP applications

was recorded. Complete success was considered as resolving air leaks. After PAL was resolved, the chest tube was removed over days. During the follow-up period, complications of the procedure were evaluated.

The study was approved by Ankara City Hospital, No. 2 Clinical Research Ethics Committee (05.05.2021/E2-21-431).

RESULTS

Of 11 children, males were more common (n=7, 63.9%). The mean age of children who underwent ABPP for PAL was 13.4±2.1 years (IQR 10-17). The mean number of repeating procedures was 1.8 ranging from 1 to 3 applications. The demographics and etiologic causes are given in table I. In our study group, thoracic procedures secondary to spontaneous pneumothorax was the most common etiologic cause. The mean time of PAL before

Table I: The demographics and etiologic causes of patients with PAL.

Demographic and etiologic features	Persistent air leak (PAL) n (%)
Age/Years (mean.±.SD.)	14.3±2.1 (10-17)
Gender	
Girls	4 (36.1)
Boys	7 (63.9)
The etiology of PAL	
After thoracic procedures	
Video-assisted thoracoscopic surgery due to spontaneous pneumothorax	5 (63.6)
Thoracoscopic lung biopsy	2 (63.6)
Thoracic trauma with chest tubes	
Penetrating thoracic trauma	2 (36.4)
Blunt thoracic trauma	2 (36.4)

Table II: The data of ABPP for PAL.

The data of ABPP	n (%)
The rate of recovery	
After 1 st ABPP	6 (54.5)
After 2 nd ABPP	3 (27.2)
After 3 rd ABPP	2 (18.3)
After all ABPP	11 (100)
Total (mean value, range)	1.9 (1-3)

Table III: The mean number of ABPP according to air leak classification.

Cerfolio Classification of PAL	n (%)	The mean number of ABPP
Grade 1. During forced expiration only	6 (100)	1.7
Grade 2. Expiratory only	3 (100)	2.1
Grade 3. Inspiratory only	0	0
Grade 4. Continuous bubbling present in the air leak	2 (100)	3.1

the first application of ABPP was 8.2 days (IQR 5-10). Complete recovery was possible in six cases after the first application (54.5%) and in three cases after two applications (27.2%), in two cases after three applications (18.3%). PAL improved in all cases after repeating ABPP procedures (100% healing). The mean number of ABPP according to air leak classification is given in table II. We had seen no complications in terms of respiratory distress due to the application of ABPP or infection.

DISCUSSION

Prolonged air leaks remain a common complication, whether it is due to primary or secondary causes. Although surgical correction has been accepted as gold standard therapy, every surgical intervention carries its risks (9,10). Herein, we report about our experiences of autologous blood patch pleurodesis (ABPP) in children as an alternative treatment option for PAL. ABPP is an easily applicable therapy with high effectiveness and being away from complications and, the use of ABPP for PAL was successful in all patients of our series.

The exact mechanism of the “blood patch” is still unknown, but it is thought that the instilled blood seals the region of air leak by clotting. Another possible mechanism is thought to be related to pleurodesis. In true pleurodesis, the healing process occurs with the development of pleural adhesions, which is a time-consuming condition. But the recovery time in ABPP is much shorter. In this situation, fibrin development is more likely to close air leaks than pleurodesis (2,11). In our series, the recovery rate of 54.5% after the 1st application of ABPP is an example of rapid healing with no further requirement. Also, the mean success of blood pleurodesis after the initial application was reported 76.6% in PAL in a review of large clinical series (2,12). Therefore, ABPP should be considered as a method that can provide improvement both in a fast time and maybe with a single attempt. Nevertheless, it is noteworthy that pediatric studies achieved excellent recovery rates with multiple instillations (13,14).

The overall success was found 92% to 100% in adults with PAL (13,15,16). Despite its use in adults, there is still limited experience in childhood. While previous pediatric reports have provided lower resolution rates after ABPP, recent experience in the pediatric population indicates higher success rates. This indicates that ABPP can be used successfully in the child age group, and we were able to achieve improvement in all patients with multiple administrations (9,13).

Autologous blood for pleurodesis was first described in the late 1980s for primary and secondary pneumothorax (17). ABPP is found superior to conservative treatment for pneumothorax-related PAL (16,18). Also, successful results of ABPP have been reported in resolving persistent air leaks following thoracic surgeries (5,12). Despite the more widespread use of ABPP, the technique and basic principles in children have

not been fully defined. The ABPP is a simple technique without the requirement of advanced equipment. In adults, the main principles of ABPP include instillation of 50-150 cc venous blood sample into the thoracic cavity, monitoring the chest tube for 3-4 hours without free drainage, repeating the procedure after 24 hours if necessary, with a maximum limit of three applications (2,5). Infusion of 10 ml saline after administration of venous was recommended to prevent clotting (2,12,16). The appropriate amount of blood for ABPP is 1-2 ml/kg in children (9,13,14). In a recent review, it was recommended that ABPP can be safely repeated every 24 hours if the previous application did not work. Although we did not have a patient who required more than three interventions, the a maximum limit of three ABPP procedures is recommended (16).

Among the important complications related to ABPP, infections and fever should be considered. No serious complications were noted in our study. Presence of fever should be taken into account in patients undergoing ABPP. Because fever can be a preliminary sign of infection, as well as an inflammatory response in the pleura caused by blood given to the thorax (5, 16). While the incidence of serious complications related to ABPP has been reported very rare, we did not see any complications in our series either (13,16,18). This condition can be related to our limited number of patients.

The principal limitation of this study is that the study had a retrospective design. The study included very limited sample size due to the rarity of the condition.

CONCLUSION

We recommend using ABPP for PAL, and we believe that ABPP is an easily applicable therapy with high effectiveness and being away from complications. ABPP was successful in all patients of our series, with no experiences of complications.

REFERENCES

1. Sakata KK, Reisenauer J, Kern RM and Mullan JJ. Persistent air leak-review. *Respir Med* 2018;137:213-8.
2. Rinaldi S, T Felton, and A Bentley. Blood pleurodesis for the medical management of pneumothorax. *Thorax* 2009;64:258-60.
3. Henry M, Arnold T and Harvey J. BTS guidelines for the management of spontaneous pneumothorax. *Thorax* 2003;58: ii39-52.
4. Cerfolio RJ and Bryant AS. The management of chest tubes after pulmonary resection. *Thorac Surg Clin* 2010;20:399-405.
5. Shackcloth MJ, Poullis M, Jackson M, Soorae A, Page RD. Intrapleural instillation of autologous blood in the treatment of prolonged air leak after lobectomy: a prospective randomized controlled trial. *Ann Thorac Surg* 2006;82:1052-6.
6. Halifax R, Yousuf A, Jones HE, Corcoran JP, Psallidas I and Rahman NM. Effectiveness of chemical pleurodesis in spontaneous pneumothorax recurrence prevention: a systematic review. *Thorax* 2017;72:1121-31.
7. Györik S, Erni S, Studler U, Wuerz RH, Tamm M and Chhajed PN. Long-term follow-up of thoracoscopic talc pleurodesis for primary spontaneous pneumothorax. *Eur Respir J* 2007;29:757-60.
8. Light RW, Hara VSO, Moritz TE, McElhinney Aj, Butz R, Haakenson CM et al. Intrapleural tetracycline for the prevention of recurrent spontaneous pneumothorax: results of a Department of Veterans Affairs cooperative study. *JAMA* 1990;264:2224-30.
9. Lillegard JB, Kennedy RD, Ishitani MB, Zarroug AE, Feltis B. Autologous blood patch for persistent air leak in children. *J Pediatr Surg* 2013;48:1862-6.
10. Dugan KC, Laxmanan B, Murgu S and Hogarth DK. Management of persistent air leaks. *Chest* 2017;152: 417-23.
11. Dumire R, Crabbe MM, Mappin FG and Fontenelle LJ. Autologous "blood patch" pleurodesis for persistent pulmonary air leak. *Chest* 1992;101:64-6.
12. Lang-Lazdunski L and Coonar AS. A prospective study of autologous 'blood patch'pleurodesis for persistent air leak after pulmonary resection. *Eur J Cardiothorac Surg* 2004;26:897-900.
13. Pruitt LC, Kastenber ZJ, Fenton SJ and Short S. Early use of autologous blood patch pleurodesis in children is successful in resolving persistent air leaks. *J Pediatr Surg* 2021;56:629-31.
14. Mingorance AN, Pastor Vivero MD, Leon MC, Dominguez SBR and Soler JL. Autologous "blood patch"pleurodesis: A safe and useful treatment for persistent pneumothorax in children. *An Pediatr (Barc)* 2016;85:157-8.
15. de Andrés JJR, Blanco S and de la Torre M. Postsurgical pleurodesis with autologous blood in patients with persistent air leak. *Ann Thorac Surg* 2000;70:270-2.
16. Campisi A, Dell Amore A, Gabryel P, Ciarrocchi AP, Sielewicz M, Zhang Y, et al. Autologous Blood Patch Pleurodesis: A Large Retrospective Multicenter Cohort Study. *Ann Thorac Surg* 2021; S0003-4975(21)01386-2.
17. Robinson CL. Autologous blood for pleurodesis in recurrent and chronic spontaneous pneumothorax. *Can J Surg* 1987;30:428-9.
18. Ibrahim IM, Abd Elaziz ME and El-Hag-Aly MA. Early autologous blood-patch pleurodesis versus conservative management for treatment of secondary spontaneous pneumothorax. *Thorac Cardiovasc Surg* 2019;67: 222-6.