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Missed Hemothorax After Posterior Correction Surgery for Pediatric Spinal Deformity

Alparslan Kapisiz[1], Cem Kaya[1], Zafer Turkyilmaz[1], Ramazan Karabulut[1], Alim Can Baymurat[2], Kaan Sonmez[1]

1 Gazi University, Faculty of Medicine, Departments of Pediatric Surgery, Ankara, Türkiye

2 Medical Faculty, Gazi University, Department of Orthopedics and Traumatology, Besevler, Ankara, Türkiye

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Abstract

Background: Hemothorax represents a rare but serious complication after posterior correction surgery (PCS) for spinal deformities, occurring in roughly 0.1% of cases. When diagnosis is delayed or the condition is missed, the clinical consequences can be severe. In this retrospective review, we evaluated pediatric patients who developed hemothorax after PCS, aiming to describe the perioperative diagnostic difficulties and management experiences encountered.

Methods: From 2016 to 2021, we retrospectively reviewed the records of 135 children who underwent posterior correction surgery for spinal deformity. Five of these patients were diagnosed with postoperative hemothorax and were included in the study. The variables assessed comprised demographic information, intraoperative imaging findings, the onset of hemodynamic deterioration, and the treatments applied.

Results: The mean patient age at the time of surgery was 12.4 ± 2.9 years. Intraoperative posteroanterior chest radiographs were routinely obtained to confirm the placement of spinal instrumentation. A retrospective review of these films showed clear signs of hemothorax in four children and suspicious findings in one. None of the cases received intraoperative intervention for hemothorax. Because of subsequent hemodynamic instability, all five were transferred from the ward to the intensive care unit at different times after surgery. Chest tube drainage was required in three patients, thoracentesis in one, and surgical decortication in another.

Conclusion: Early recognition of hemothorax plays a key role in preventing postoperative complications. For patients considered at higher risk, intraoperative bedside thoracic ultrasonography should be routinely employed. When this option is not accessible, performing a chest X-ray in the reverse Trendelenburg position before extubation may help reduce the likelihood of a missed diagnosis

Keyword: Hemothorax, Spinal deformity, Posterior correction surgery, Pediatric spine surgery, Intraoperative imaging

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Correspondence / Yazışma Adresi: *Alparslan Kapisiz, Medical Faculty, Gazi University, Department of Pediatric Surgery, Besevler, 06550, Ankara, Türkiye*
e-mail: alparslankapisiz@gazi.edu.tr

Pediatrik Spinal Deformite Nedeniyle Uygulanan Posterior Düzeltme Cerrahisi Sonrası Gözden Kaçan Hemotoraks

Öz

Giriş: Hemotoraks, spinal deformiteler için posterior düzeltme cerrahisi (PCS) sonrası nadir fakat ciddi bir komplikasyondur ve vakaların yaklaşık %0,1'inde görülür. Tanı geciktiğinde veya durum gözden kaçırıldığında, klinik sonuçlar ciddi olabilir. Bu retrospektif derlemede, PCS sonrası hemotoraks gelişen pediatrik hastaları değerlendirerek, perioperatif tanı zorluklarını ve karşılaşılan tedavi deneyimlerini tanımlamayı amaçladık.

Yöntemler: 2016-2021 yılları arasında, spinal deformite nedeniyle posterior düzeltme ameliyatı geçiren 135 çocuğun kayıtlarını retrospektif olarak inceledik. Bu hastalardan beşine postoperatif hemotoraks tanısı konuldu ve çalışmaya dahil edildi. Değerlendirilen değişkenler demografik bilgiler, intraoperatif görüntüleme bulguları, hemodinamik bozulmanın başlangıcı ve uygulanan tedavilerden oluşuyordu.

Bulgular: Ameliyat sırasındaki ortalama hasta yaşı 12,4 ± 2,9 yıldı. Spinal enstrümantasyonun yerleşimini doğrulamak için rutin olarak ameliyat sırasında posteroanterior göğüs radyografileri çekildi. Bu filmlerin retrospektif incelemesinde dört çocukta net hemotoraks belirtileri, birinde ise şüpheli bulgular görüldü. Olguların hiçbirine hemotoraks için ameliyat sırasında müdahale edilmedi. Daha sonra gelişen hemodinamik instabilite nedeniyle beş hasta da ameliyattan sonra farklı zamanlarda servisten yoğun bakım ünitesine transfer edildi. Üç hastada göğüs tüpü drenajı, birinde torasentez ve bir diğerinde cerrahi dekortikasyon gerekti.

Sonuç: Hemotoraksın erken tanısı, postoperatif komplikasyonların önlenmesinde önemli bir rol oynar. Daha yüksek risk altında olduğu düşünülen hastalarda, ameliyat sırasında yatak başı torasik ultrasonografi rutin olarak kullanılmalıdır. Bu seçenek mümkün olmadığında, ekstübasyondan önce ters Trendelenburg pozisyonunda göğüs röntgeni çekilmesi, tanı atlanma olasılığını azaltmaya yardımcı olabilir.

Anahtar kelimeler: Hemotoraks, Spinal deformite, Posterior düzeltme cerrahisi, Pediatrik omurga cerrahisi, İntraoperatif görüntüleme.

INTRODUCTION

Hemothorax is defined as the collection of blood within the pleural cavity, specifically between the visceral and parietal pleura. Etiologically, it can arise spontaneously, follow trauma, or occur as an iatrogenic event related to medical or surgical procedures[1]. In pediatric spinal deformity surgery, posterior correction procedures (PCS) can occasionally lead to iatrogenic hemothorax because of the surgical field's close relationship to thoracic organs and vascular structures. During the past two decades, notable improvements in surgical tools and operative methods have contributed to a significant rise in the number of spinal deformity corrections carried out worldwide[2]. Even though the occurrence of hemothorax after PCS is quite rare—about 0.1%—failure to identify it promptly can cause diagnostic delays, prolonged hospital stays, and higher morbidity rates[3]. Although a few case reports exist, there is still limited comprehensive evidence on how hemothorax associated with PCS is recognized and managed during the perioperative period. The aim of this retrospective study is to present our center's experience with hemothorax occurring after PCS and to emphasize the clinical significance of careful intraoperative observation and structured postoperative monitoring to avoid delayed recognition

METHODS

After receiving approval from the Gazi University Clinical Research Ethics Committee (Date: October 18, 2021; Decision no: 02), we retrospectively examined the electronic medical records of pediatric patients who underwent posterior correction surgery for spinal deformity at our institution between

2016 and 2021. Out of a total of 135 patients, five were found to have developed postoperative hemothorax, and these cases formed the basis of the present analysis. The data extracted for each case included demographic details (age and sex), intraoperative imaging results that suggested possible hemothorax, the time at which hemodynamic instability began, and the nature and timing of interventions performed to manage the condition (Table 1).

Table I: Details of the posterior correction surgery for spinal deformity patients with hemothorax

Case Number	**1**	**2**	**3**	**4**	**5**	**Value**
Age(years)	17	10	12	10	13	12.4 ± 2.88
Sex, female/male	F	M	F	F	F	4/1
Side, left/right	L	L	R	L	R	3/2
Presence of peroperative hemothorax	+	-	+	+	+	4
Inpatient transfers to the Intensive Care Unit, postoperative day	1	1	3	1	1	1.4 ± 0.89
Timing of draining for hemothorax, postoperative day	2	7	7	1	2	3.8 ± 2.94
Amount of blood drainage	650	500	400	750	900	640 ± 198.11
Chest tube removal time (day)	8	-	6	4	7	6.25 ± 1.70

RESULTS

This study analyzed five pediatric patients (four females, one male) who experienced postoperative hemothorax after posterior correction surgery. The mean age at surgery was 12.4 ± 2.88 years (range, 10–17 years). Intraoperative posteroanterior (PA) chest X-rays, initially performed for verifying implant placement, were reviewed retrospectively. Clear evidence of hemothorax was found in four patients, while one case demonstrated radiographic suspicion of hemothorax (Figure 1). None of the patients underwent intraoperative management for hemothorax. All were extubated and transferred to the orthopedic ward. Subsequently, four patients developed hemodynamic instability within the first 24 hours and were moved to the intensive care unit (ICU). The remaining patient, whose radiograph had shown a suspicious finding, developed instability on the third postoperative day and was transferred to the ICU at that time. Hemothorax management was initiated following ICU admission in all cases. Chest tube thoracostomy was performed for cases 1, 4, and 5, with tube duration averaging 6.33 ± 2.08 days (range, 4–8 days). Ultrasound-guided thoracentesis was carried out in the second patient (Figure 2). In the third patient, an 8F pigtail catheter was inserted on postoperative day 7 under ultrasound guidance. As fluid evacuation remained insufficient, the device was removed on day 10 and substituted with a chest tube. When the hemothorax persisted despite chest tube drainage (Figure 3), thoracoscopic decortication was undertaken on postoperative day 11. The postoperative course was uneventful in all cases. In every instance, the hemothorax was identified on the convex aspect of the spinal curvature. Preoperative and postoperative Cobb angle measurements are provided in Table 2.

Figure 1: Left hemothorax in the perioperative image of the fourth case

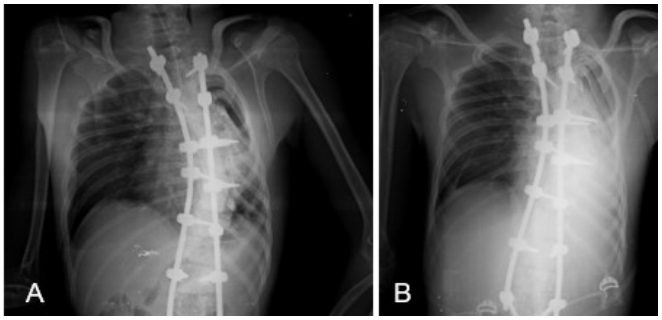

Figure 2: (**A**) Perioperative image of the second case. (**B**) Before thoracentesis image of the same patient on postoperative 7th day

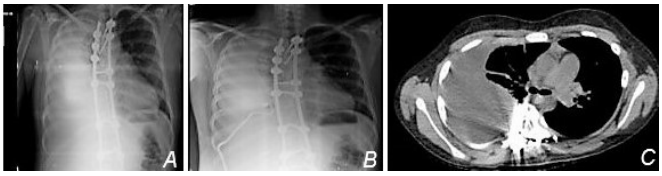

Figure 3: (**A**) The image before the 8f pigtail catheter was placed in case 3 with ultrasound guidance on the 7th postoperative day. (**B**) Image after pigtail catheter insertion. (**C**) CT image before decortication

Table II: Preoperative (preop) and postoperative (postop) Cobb angles, hemothorax site and treatment approach for hemothorax patients

Case	Scoliosis		Kyphosis		Hemothorax site	Treatment
	Preop	Postop	Preop	Postop		
1	20 (T7-T12)	7 (T7-T12)	73 (T2-T12)	45 (T2-T12)	Convex	Tube thoracostomy
2	85 (T3-T12)	33 (T3-T12)	57 (T2-T12)	40 (T2-T12)	Convex	Thoracentesis
3	67 (T5-T12)	21 (T5-T12)	27 (T2-T12)	32 (T2-T12)	Convex	Pigtail + decortication
4	56 (T2-T9)	27 (T2-T9)	32 (T2-T12)	40 (T2-T12)	Convex	Tube thoracostomy
5	78 (T5-T12)	27 (T5-T12)	52 (t2-T12)	36 (T2-T12)	Convex	Tube thoracostomy

DISCUSSION

Hemothorax, though rare, may vary considerably in severity and response to treatment following posterior correction surgery. Previous large-scale studies have reported hemothorax incidences of 0.5% to 1.2% in pediatric scoliosis surgery[4,5], while a large single-center series documented a pleural effusion incidence of 0.84% after deformity correction[6]. Such lower rates may be partly due to undetected small or asymptomatic hemothoraces when routine perioperative screening is not implemented. In our series, hemothorax was retrospectively identified—or radiographically suspected—on intraoperative PA radiographs in several cases, yet no intraoperative treatment was performed. This delay resulted in postoperative deterioration requiring procedural intervention, highlighting the clinical impact of missed intraoperative recognition.

Hemothorax refers to the accumulation of blood within the pleural cavity and is a challenging complication encountered in various clinical settings. While thoracic trauma remains the most frequent cause, it can also arise as a result of invasive interventions such as thoracentesis, central venous catheter insertion, tube thoracostomy, biopsy, or spinal deformity correction surgery involving the thoracic area. Failure to promptly recognize hemothorax—regardless of the underlying cause—can lead to considerable morbidity, extended hospital stays, and the necessity for further invasive treatments.

Typically, hemothorax is first managed by inserting a large-bore chest tube. Correct tube positioning is vital to ensure efficient evacuation of the pleural space. Inadequate drainage results in a retained hemothorax, which carries the risk of late complications such as empyema or fibrothorax. In these cases, surgical decortication often becomes necessary[7].

In the patient who underwent posterior correction surgery, persistent radiographic opacity combined with minimal output despite correct tube positioning led to the diagnosis of retained hemothorax. A pigtail catheter was placed on postoperative day 7; however, insufficient drainage required the insertion of a chest tube on day 10. Continued evidence of hemothorax on chest radiography and CT scans subsequently led to thoracoscopic decortication on postoperative day[11].

Reports in the literature suggest that hemothorax is a rare outcome after posterior correction surgery for spinal deformity, and that the majority of such cases respond well to conservative management without necessitating additional surgical intervention[3]. Nevertheless, there is limited information in the literature regarding specific management approaches, the timing of clinical deterioration, and patient responses to treatment. Many publications do not report the exact onset of hemodynamic instability or the timing of therapeutic action. For example, Ogura et al. described a patient who developed hemodynamic instability 20 minutes after extubation, with chest radiography and contrast-enhanced CT confirming a massive hemothorax within 25 minutes postoperatively. A chest drain was inserted 110 minutes after the completion of surgery[8]. Similarly, Pang et al. documented hemodynamic decline 18 hours after extubation, followed by the detection of a massive hemothorax; however, it remained unclear whether any imaging was performed before extubation[3].

While multiple retrospective studies have identified hemothorax as a possible complication of posterior correction surgery[2,9,10], only a small number have provided detailed clinical timelines or applied standardized intervention criteria. Liang et al. observed that when hemothorax develops following spinal correction surgery, it is often successfully treated through non-invasive approaches. However, in their series, chest tubes were inserted in 18 of 22 patients, with no disclosure of the exact timing of physiological decline or the interventions performed[6]. Unlike these prior reports, our series offers precise documentation of both the onset of clinical deterioration and the sequence of interventions, thereby delivering a more defined basis for guiding clinical management.

In all cases within our series, hemothorax was recognized and appropriate management was initiated only after respiratory distress developed in the postoperative period. Retrospective review of intraoperative images showed that hemothorax had been missed in four of the five patients. We believe this was due to the primary focus being on verifying implant placement during intraoperative image assessment. These findings emphasize the need for intraoperative imaging to serve a dual

purpose—evaluating not only hardware positioning but also potential thoracic complications.

In the majority of cases, hemothorax is diagnosed during postoperative clinical observation, most often after the onset of respiratory distress. Such delays in recognition can cause emotional strain for patients and their families, as well as contribute to higher morbidity. To avoid these complications, hemothorax should be considered as a potential intraoperative event, and patients must be assessed with this possibility in mind. If hemothorax requiring intervention is identified, the appropriate procedure should ideally be completed before the patient is extubated. Despite thorough intraoperative assessment, a small risk of missing this complication always remains. Close monitoring of respiratory function after surgery is therefore essential, and any suspicion of hemothorax should prompt immediate evaluation to prevent further deterioration. Because major vessels lie very near the anterior portion of the thoracic vertebrae, and segmental vessels run along their sides, both the surgical and postoperative periods demand particular caution[11]. Using a coordinated, multidisciplinary checklist during surgery can assist in recognizing such issues earlier and minimizing treatment delays. Moreover, well-structured postoperative observation protocols have been shown to reduce the frequency of serious pleural complications[12].

Early recognition and prompt management of hemothorax are crucial for achieving better postoperative results. During spinal deformity correction, surgeons often use posteroanterior chest X-rays to check the position of the implants. Yet, this imaging method is not very sensitive for identifying hemothorax—especially when the patient is lying in the prone position, where blood tends to pool in areas that are harder to visualize. In this posture, blood is more likely to collect along the anterior pleural surface rather than in the diaphragmatic recesses, thereby reducing its visibility on standard radiographs.

While upright chest radiography offers greater sensitivity than supine imaging, obtaining such views during surgery is generally impractical. Additionally, chest X-rays in any position require a considerable amount of intrapleural blood—usually between 300 and 500 mL—to obscure the costophrenic angle. Zeiler et al. reported that, in the supine position, up to 1000 mL of blood may go undetected[1]. A similar drawback may exist when the patient is in the prone position. Mahoozi et al. reported that applying the reverse Trendelenburg position during surgery could improve imaging sensitivity, allowing identification of even minimal hemothorax volumes[13].

Bedside thoracic ultrasonography has demonstrated greater sensitivity than the combined use of chest radiography and physical examination for identifying hemothorax[14]. Ultrasound is capable of detecting pleural fluid volumes as low as 20 mL, whereas chest radiography generally requires at least 175 mL to visualize the presence of fluid[15].

While the study's retrospective design and the small cohort of five patients could be viewed as limitations, it represents the first focused investigation into both intraoperative and postoperative approaches to managing hemothorax following posterior correction surgery. Future prospective research involving larger cohorts is necessary to confirm and build upon these results. Collaborative multicenter studies could increase case numbers, enhance statistical robustness, and facilitate the development of targeted preventive measures for pediatric patients at elevated risk[16].

CONCLUSION

Considering the discussion points, we strongly recommend the use of intraoperative bedside

thoracic ultrasonography to reduce the likelihood of overlooking clinically significant or radiographically suspected hemothorax that requires intervention. In situations where bedside ultrasonography is unavailable, obtaining a chest radiograph in the reverse Trendelenburg position before extubation should be performed to lessen the risk of an undiagnosed hemothorax.

Ethical approval: After receiving approval from the Gazi University Clinical Research Ethics Committee (Date: October 18, 2021; Decision no: 02), we retrospectively examined the electronic medical records of pediatric patients who underwent posterior correction surgery for spinal deformity at our institution between 2016 and 2021.

Conflict of Interest: The authors declared no conflicts of interest.

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