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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

Conservative Treatment of Mildly Symptomatic Large Extradural Hematomas in The Pediatric Age Group: A Report of 20 Cases

Pediatrik Yaş Grubunda Hafif Semptomatik Büyük Ekstradural Hematomların Konservatif Tedavisi: 20 Vaka Serisi

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ABSTRACT

Aim: Conservative treatment is a safe alternative to surgical treatment in patients with asymptomatic or mildly symptomatic extradural hematoma seen in the pediatric age group. There is still a debate about patient selection criterias. This study highlights the radiological and clinical features of pediatric large EDH patients treated without surgery.

Material and Methods: In this retrospective-cohort study, we present a review of the data of 20 pediatric EDH patients treated in Health Sciences University, Bursa Yüksek Ihtisas Training and Research Hospital between 2015 and 2020. This study; includes patients with Glasgow Coma Scale (GCS) 14+ and diagnosed EDH thickness ≥ 15mm in computed tomography (CT), treatment protocol and outcomes.

Results: Of the 206 patients diagnosed with EDH, 131 (63,5 %) had an initial GCS ≥ 14. Furthermore, 23 (11,1 %) patients had EDH thickness ≥ 15 mm. 3 patients were excluded from study because of emergent surgery. The number of patients included in the study was 20 and all patients had a GOS score of 5 on at least one -year follow-up.

Conclusion: According to our results, conservative treatment is an optimal alternative to surgical treatment in pediatric large EDH patients. However, patient selection and clinical features are very important.

Keywords: Epidural hematoma, conservative management, head trauma, pediatric patients, traumatic brain injury

ÖZ

Amaç: Pediatrik yaş grubunda görülen asemptomatik veya hafif semptomatik ekstradural hematomu olan hastalarda konservatif tedavi cerrahi tedaviye güvenli bir alternatiftir. Hasta seçim kriterleri hakkında hala bir tartışma vardır. Bu çalışma, ameliyatsız tedavi edilen pediatrik büyük EDH hastalarının radyolojik ve klinik özelliklerini vurgulamaktadır.

Gereç ve Yöntemler: Bu retrospektif-kohort çalışmada, Sağlık Bilimleri Üniversitesi Bursa Yüksek İhtisas Eğitim ve Araştırma Hastanesi'nde 2015-2020 yılları arasında tedavi gören 20 pediatrik EDH hastasının verilerinin bir derlemesini sunuyoruz. Bu çalışma; Glasgow Koma Skalası (GCS) 14+ olan ve bilgisayarlı tomografide (BT) EDH kalınlığı ≥ 15 mm olan hastaları, tedavi protokolünü ve sonuçlarını içermektedir.

Bulgular: EDH tanısı konan 206 hastanın 131'inde (%63,5) başlangıç GCS ≥ 14 idi. Ayrıca 23'ünde (%11,1) EDH kalınlığı ≥ 15 mm idi. Acil cerrahi nedeniyle 3 hasta çalışma dışı bırakıldı. Çalışmaya dahil edilen hasta sayısı 20 idi ve tüm hastaların en az bir yıllık takipte GOS skoru 5 idi.

Sonuç: Sonuçlarımıza göre, pediatrik büyük EDH hastalarında konservatif tedavi cerrahi tedaviye optimal bir alternatiftir. Ancak hasta seçimi ve klinik özellikler çok önemlidir.

Anahtar Kelimeler: Epidural Hematom, konservatif tedavi, kafa travması, çocuk hasta, travmatik beyin hasarı

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Introduction

Extradural hematoma (EDH) is a neurosurgical emergency that typically occurs following a trauma. The timing of treatment is critical because if it is not treated, it can result in herniation syndromes due to an acute increase in intracranial pressure (1). Early treatment is also critical for lowering morbidity and mortality (2). According to their guidelines, surgical decompressive craniectomy or craniectomy should be performed within four hours of the onset of significant symptoms to achieve a good outcome (3,9). Although the arteries injured in EDH vary, the middle meningeal artery is usually injured in trauma. Additionally, the sinuses (superior sagittal sinus or lateral sinus) and diploic vein may be the source of the bleeding. The majority of pediatric extradural hematomas (PEDH) are caused by venous sources. Because the majority of PEDH comes from venous sources, the slow expansion of bleeding causes premature clotting. As a result, PEDHs are better suited for non-surgical treatment than EDHs from the arterial system (3).

EDH is common in both pediatric and adults' populations. PEDH is thought to be responsible for 2–4, 5% of all pediatric traumatic brain injury (4). In symptomatic patients with diagnosed PEDH, urgent craniotomy for evacuation of blood clot evacuation is the standard treatment for quick and complete recovery (5). Late diagnosis and treatment of symptomatic PEDH raise morbidity and mortality rates comparable to those seen in adults. Previous research has suggested that in patients with asymptomatic PEDH, conservative management with close neurological monitoring and serial computed tomography (CT) may be a safe alternative to craniotomy (5,7).

The goal of our study was to show clinically and radiologically that children with mildly symptomatic or asymptomatic large EDH can be treated conservatively. We also attempted to demonstrate that craniotomy can be protected from long-term socio-cultural and psychological consequences.

Material and Methods

This study looked at 206 patients who were admitted to the hospital with PEDH between May 2015 and June 2020 after institutional ethical approval (Date:08-01-2020, Decision No:2011-KAEK-25 2020/01-26). Only patients in the pediatric age group (less than 18 years old) traumatic EDH patients with a Glasgow Coma Skale (GCS) score of ≥14 were included in our study. Patients with no focal neurological findings but mild symptoms and signs of an increase in intracranial pressure (vomiting, headache etc.) were treated conservatively. We also included patients with EDH thicknesses less than ≥15 mm. Patients with PEDH who had surgery, patients with additional intracranial lesions (depression fracture, subdural hematoma, cerebral contusion, subarachnoid hemorrhage), patients with infratentorial EDH, patients with a Pediatric Trauma Score of less than 8, and patients with additional systemic disease (coagulopathy, kidney failure) were all excluded from the study. Patients who were unable to attend follow-up appointments were also excluded from the study. We presented 20 patients who were treated conservatively by this patient.

The age, gender, mechanism of injury, location and thickness of EDH, presence of skull fracture, change in EDH thickness, initial GCS score evaluation, hospital admission time, and treatment outcomes of patients were all evaluated descriptively. The Glasgow Outcome Scale (GOS) test was used to assess the patients 'neurological recovery. At the 12-month follow-up, all patients 'social and intellectual levels were assessed. All of the parents adhered to our PEDH treatment protocol. Table 1 summarizes the clinical features and management process of 20 patients.

All the eligible patients received non-surgical treatment and were followed up on in the neurosurgical intensive care unit (NSICU) for close neurological monitoring. An attending neurosurgeon, neurosurgery resident, or trained NSICU nurse performed hourly neurological examinations (deterioration of consciousness, vomiting). The patients were transferred to the neurosurgery service, where 24-hour neurosurgical control was available. Continuous neurological monitoring also included measuring the patients 'pupil diameter, pulse rate, blood pressure, and respiratory patterns. In our study, if a patient's neurological condition worsened during their hospitalization, emergency surgery was available within 30 minutes.

Small PEDH patients who do not require surgery are routinely followed up on with additional CT imaging in the event of deterioration in their neurological conditions or clinical necessity (such as increasing recurrent pojectile vomiting). A CT frequency protocol for monitoring large PEDH was developed in this study. CTs were performed on admission and on the eighth hour after the initial presentation (unless there was acute worsening in symptoms). Furthermore, those who had complaints like vomiting and headaches despite symptomatic treatment were given additional CT scans. Magnetic Resonance Imaging (MRI) has been preferred, particularly for long-term follow-ups, in order to reduce the number of CT scans due to potential radiation effects.

Radiological findings are reported in Table 2.

After discharge, all patients were followed up on in neurosurgery outpatient clinics at one-month, three-month, and twelve-month intervals. Furthermore, 6th month follow-up was performed if necessary (patients with residual hematoma/calcification on a 3rd month CT/MRI or presence of clinical necessity). Each visit included a thorough neurological examination. Furthermore, a standardized questionnaire was used to collect the parent's subjective opinion of the patient's quality of life.

Results

131 (63,5%) of the 206 patients diagnosed with PEDH had an initial GCS of ≥14. PEDH thickness was ≥15 mm in 23 (11.1%) of the patients. Three patients were excluded from the study because they had undergone surgery following a sudden neurological deterioration. The study included the remaining 20 patients. Six (30%) of these patients were female, while 14 (70%) were male. The average age was 8,4 ±4,03 years.

The entire study group was made up of patients who were admitted to the hospital within ≤ 24 hours of being diagnosed with EDH. The average time between the patients' accident and hospitalization was 8,4±6,07 hours.

11(55%) of the patients fell 1–2 meters. Four (20%) patients presented after being hit by a vehicle or being involved in an in-vehicle traffic accident. Other traffic accidents, such as a bicycle/skate accident that did not involve a motor vehicle, were reported by four (20%) patients. Only one patient (5%) presented after an assault (Table 1). All patients had an initial GCS of ≥14. They all lacked focal neurological deficits. Pupil responses, breathing patterns, and blood pressures were all normal. The most common symptoms in the study group were mild-to-moderate headaches, vomiting, and irritability. Ten (50%) of the patients had left-sided EDH, while the remaining ten (50%) had right-sided EDH. The average shift in the midline was 2,54±2,1mm. The average thickness of PEDH was 18,1±3,3 mm. The parietal area was the most affected area in our study (Figure 1,3), nine patients (45%). PEDH was found in the frontal region in seven patients (35%) (Figure 2). PEDH was found in the temporal regions in three patients (15%). Only one patient (5% of the total) had PEDH in the occipital region. PEDH showed multilobar localization in eight patients (40%), which was a remarkable radiological feature in our series. In our study, 14 patients (70%) had a skull fracture. Repeated CT revealed an increase in PEDH thickness in six patients (30%) and a decrease in PEDH thickness in two patients (10%). The average increase was 3,1±0,9 mm, while the average decrease was 4,5±0,5 mm. In addition, all six patients with increased hemorrhage had skull fractures. There were five parietal bone fractures and one frontal bone fractures, and there was no sinus adjacency (Table 2). There was no change in any of the patients 'midline shift. The other 12 patients had no change in PEDH thickness. An extra emergent CT was performed on eight patients (40%), who had increased headaches, vomiting, and irritability. In 17 patients, the last CT performed three months later revealed complete resolution of PEDH with no additional pathology. At the three-month follow-up, three patients had residual PEDH or dural calcification (Figure 2). An extra CT/MR was performed on these patients at the 6th month follow-up and control CTs revealed complete resorption. Ten patients (50%) had additional CT scans. As a result, we kept the number of CTs to a minimum, and the patients were monitored with neurological examinations at regular intervals. MRI was used to perform long-term follow-up of 9 (45%) patients. When the patients were discharged, their parents were educated on emergencies and given strict return-to-hospital precautions in the event of a worsening neurological status. Patients were summoned to the hospital on a regular bases for a check-up. MRI was used in the follow-up of 9 (45%) of the patients. All patients received a GOS of 5 during their yearly follow-up visit. All of the patients had returned to their pre-accident social and cognitive levels. Except for two patients (4th and 17th in Table 1) who had occasional headaches that did not require significant medical treatment, all patients had no additional symptoms. The PEDH conservative treatment protocol has been approved by all parents (Table 3).

No other signs or symptoms, seizures, or antiepileptic drugs were required in any of our patients.

Discussion

Conservative treatment may be a safe alternative to surgical treatment in children with asymptomatic or mildly symptomatic EDH. Neurosurgeons were hesitant to operate on patients with mildly symptomatic PEDH, according to the literature (12). Patients with neurological impairment, whose neurological status worsens after the first clear interval, or who are in a coma after the accident are generally operated on (6); Chen et al recommend that EDH with a hematoma volume greater than 30 ml and a midline deviation of more than 5 mm be drained by craniotomy (13). Similarly, Bejjani et al. advised surgery if the hematoma thickness was greater than 18 mm and the midline deviation was greater than 4 mm (14,15). Many multi-patient, multi-center studies have shown that patients in all age groups with EDH thickness less than 10 mm can be followed with conservative treatment (15). Furthermore, despite having fewer patients, it has been demonstrated that patients with EDH greater than 10 mm can be followed with conservative treatment, particularly in the age group (16,17). Conservative management can be more successful in pediatric EDH than in adults due to the flexible skull, non-fused suture lines, fontanelle patency, large extra-cerebral spaces, and bleeding that is usually of venous origin (3,16).

Another critical consideration is determining CT repetition intervals. Because of the potential long-term effects of excessive radiation on the developing brain, thyroid, and hematopoietic system, serial imaging in the pediatric age group is controversial (11). According to the current guidelines, the lifetime cancer risk of CT applied to a one-year-old child is as high as 1 in 150029. Previous research has suggested that there may be an increase in the thickness of EDH within 36 hours, so a follow-up CT within 36 hours is advised (18,21). Furthermore, it has been demonstrated in the literature that hemorrhage can develop within 8 hours of the accident (17,22). The average time to first CT imaging in our six patients with increased hematoma was 6 hours (2–12 h). It is critical to carefully justify pediatric CT scans. To reduce risks, methods such as dose optimization (under 10 mGy) and MRI control are required. In our study, MRI was used in 9(45%) of the patients, particularly for their third month and later controls.

In general, one of the most important factors that will guide treatment is the duration of the patient's symptoms. Previous research has found that the first 24 hours are the most dangerous for neurological deterioration due to traumatic EDH expansion, which occurs in 23% of EDH patients eight hours after the accident (16,21). Patients diagnosed with EDH less than 6 hours after trauma face a high risk of neurological deterioration, necessitating evacuation (10,22). Patients diagnosed later can be treated conservatively because the risk of delayed neurological deterioration is low (19,20). Patients with delayed onset or late admission were chosen for conservative treatment in a previous study (23,24). According to Balmer et al. the only selection criterion for conservative treatment in patients with large EDH is late admission (more than 24 hours) (16). Champagne et al and Khan et al. The mean time to referral in articles containing similar patient groups was reported to be 29.5 hours and 13.9 hours, respectively (5,7). All patients in our series were seen within the first 24 hours of being injured. The average time from the accident to hospital admission in this study was 8.4±6.07 hours.

Patient No	Sex	Age (y)	Mechanism of injury	Time from accident to admission(h)	Initial GCS	EDH Size, (mm)	EDH size increase/decrease (in repeat CT scans)
1	M	8	Falling	6	15	17	Increase
2	M	16	Assault	4	14	19	Stable
3	F	4	Falling	8	15	16	Stable
4	M	10	MVA	2	15	22	Stable
5	M	7	Falling	2	15	15	Increase
6	M	10	Falling	16	15	18	Decrease
7	M	9	Non-MVA-b RA	8	15	17	Stable
8	M	10	Falling	6	15	15	Increase
9	F	6	Falling	2	15	16	Stable
10	F	8	Non-MVA-b RA	12	15	16	Increase
11	F	5	MVA	2	15	17	Increase
12	F	4	Falling	12	14	16	Stable
13	M	15	MVA	2	14	20	Stable
14	M	7	Non-MVA-b, RA	12	15	18	Decrease
15	M	14	Falling	8	15	15	Increase
16	M	8	MVA	2	15	16	Stable
17	F	5	Non-MVA-b RA	24	15	29	Stable
18	M	15	Falling	12	15	22	Stable
19	M	2	Falling	12	15	20	Stable
20	M	5	Falling	16	15	18	Stable

M: Male, F: Female, GCS: Glasgow Coma Scale, CT: Computed Tomography, EDH: Extradural hematoma, MVA-B: Motor vehicle accident- bicycle RA:Road accident

Table 1. Presenting clinical features, management process of 20 patients.

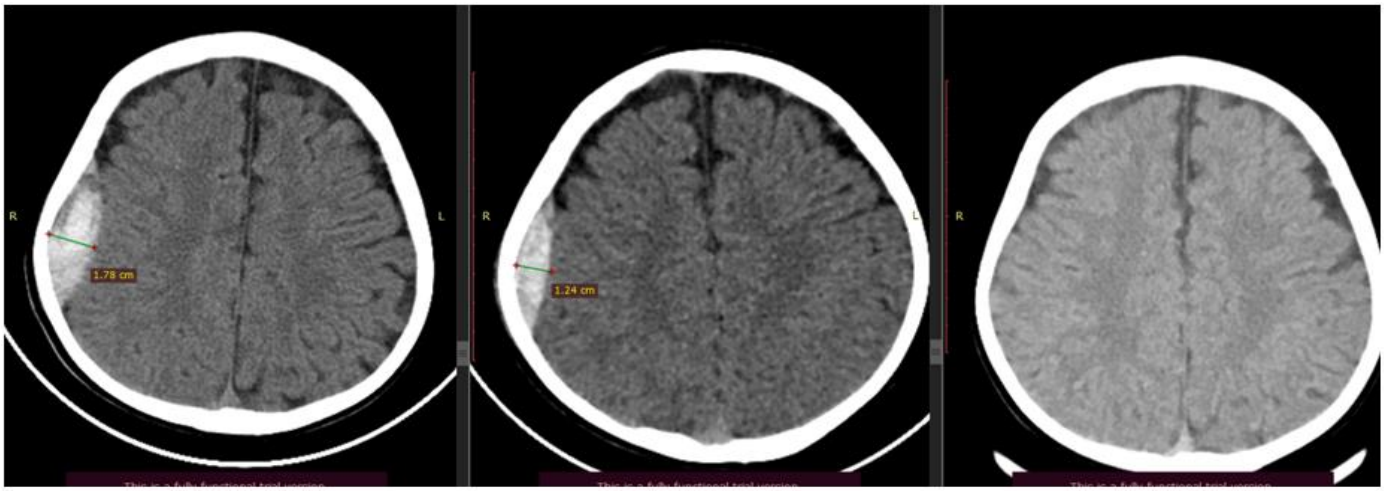

Figure 1: Axial CT scan of a 7-year-old male patient (Patient 14, table 1) shows a right parietal PEDH 18mm in thickness (A). Axial CT scan of the same patient taken 72 hours later shows a little decrease (5 mm) from the earlier scan (B). Axial CT scan of the same patient taken 3 months after discharge demonstrates marked resolution of the EDH (C).

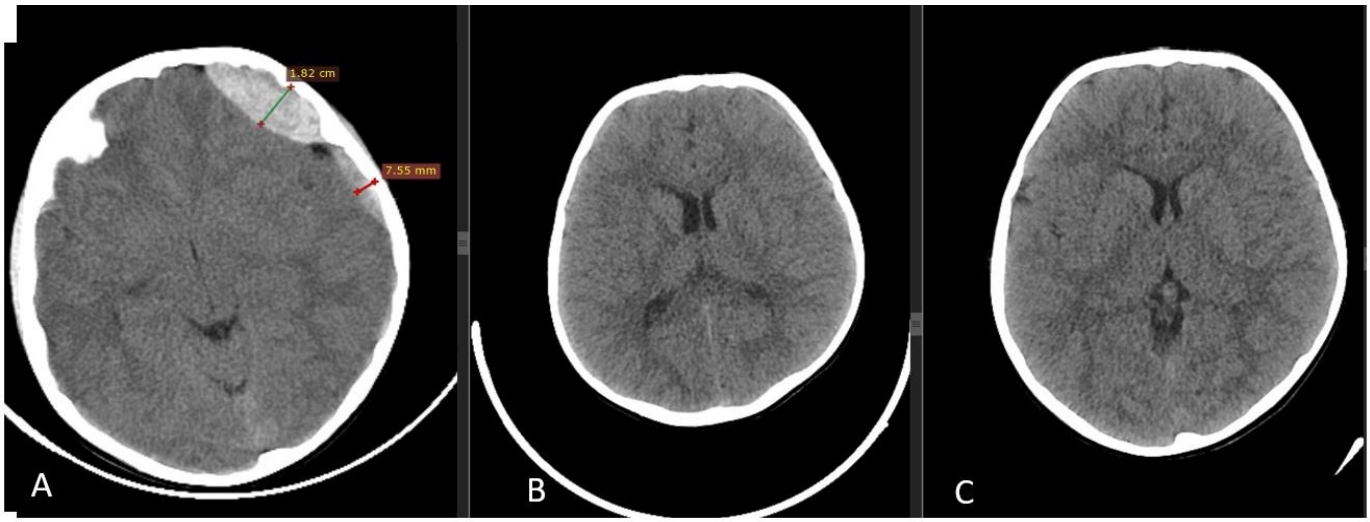

Figure 2: A 5-year-old male patient (Patient 20, table 1) was brought to the emergency department after a fall from a height of 2 meters. Axial CT scan shows a left frontal 18mm and temporal 7mm in thickness multilobar PEDH (A). Axial CT scan of the same patient taken 3 months after discharge demonstrated marked resolution of the EDH. But, some residual dural calcification was observed (B). Axial CT scan of the same patient taken 6 months after discharge showed that total rezorbe (C).

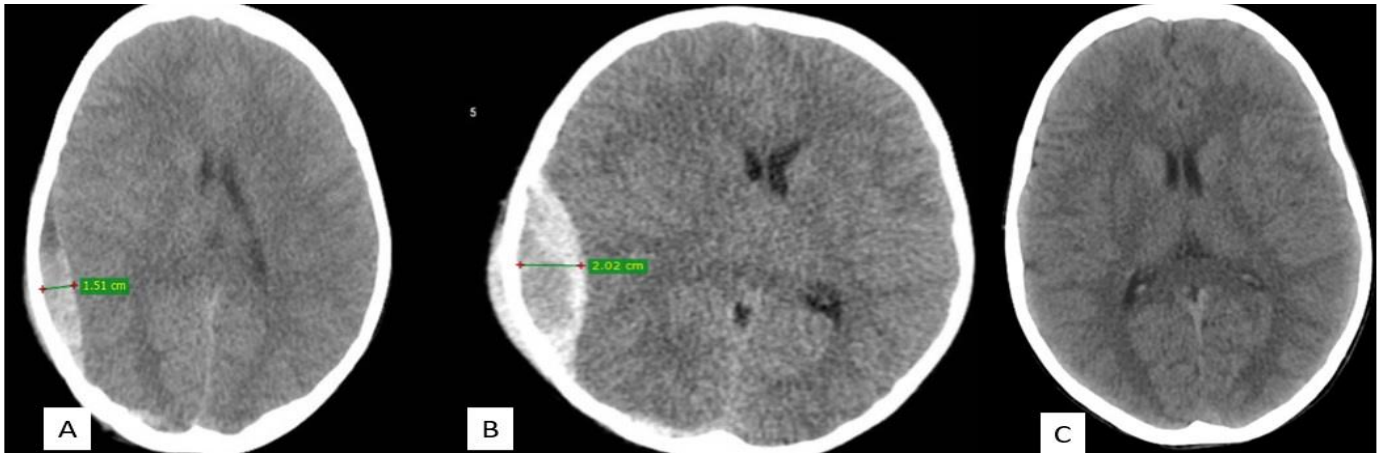

Figure 3: Axial CT scan of a 7-year-old male patient (Patient 5, Table 1) shows a right parietal PEDH 15 mm in thickness (A). Axial CT scan of the same patient taken 72 hours later shows a little increase (5 mm) from the earlier scan (B). Axial CT scan of the same patient taken 3 months after discharge demonstrates marked resolution of the EDH.

Radiologic Findings		**Number (%)**
Localisation	Frontal predominance	7 (35%)
	Temporal predominance	3 (15%)
	Parietal predominance	9 (45%)
	Occipital predominance	1 (5%)
	Multilobed	8 (40%)
Mean thickness of EDH, mm (range)		18,15 (15-29)
Mean midline shift, mm (range)		2,54±2,1 (0-5)
Skull Fracture	Present	14 (70%)
	Absent	6 (30%)

EDH: Extradural Hematoma, CT: Computed Tomography

Table 2: Comparison of 20 pediatric extradural hematoma patients' radiological findings.

No. of disabilities reported	
New onset headaches	2
Epilepsy	0
Normal school performance	20
PTSD	0
Subjectively good quality of life	20
Visual/Auditory problems	0
Regular requirement of analgesics	0

Table 3: Summary of outcomes on 1 year follow-up standardized interview

This study demonstrates that conservative treatment can be used in appropriately selected PEDH patients who are admitted to the hospital earlier than in previous studies.

Fractures near major dural vessels, particularly in the temporal region, and fractures near sinuses were previously thought to be associated with worsening neurological status in patients (19,20). In this study, 14 (70%) of the patients had a skull fracture. Although EDH can be reabsorbed within hours, complete resorption of EDH takes 3–12 weeks (8,12). In our series, the hematoma was completely resorbed in 85% of our patients by the 12th week. Tuncer et al. also stated that in patients with EDH and skull fractures, hematoma resorption is greater and faster, which may be a helpful prognostic factor for conservative rather than surgical treatment (23). Although skull fractures do not appear to necessitate surgical intervention, it is a risk factor that should be considered.

Another important factor to consider is the availability of multiple locations. When PEDH is multilobar, surgical treatment is required more frequently than when it is single lobe (15,24). Although previous studies did not focus on multilobar EDHs, they have compared them to localization data without providing a ratio. The presence of multilobarity in EDH treated conservatively ranges from 33% to 46% (16,19,20). In our study, 8(40%) had PEDH that covered more than one lobe, usually two lobes on the same side. The reason for this factor, which most likely influences hematoma thickness, is that the hematoma mass that crosses the suture line continues parallel to the skull. As a result, axial plane growth is likely to be reduced. As a result, a hematoma does not cause dura and parenchymal compression. It also demonstrates that multilobarity PEDH can be treated non-surgically.

When comparing surgical and conservative treatment options, social and psychological factors should be taken into account. In surgical practices, which is a very traumatic experience for children, three clinical phenomena have been described: 1-preoperative anxiety, 2-postoperative maladaptive behavior changes, and 3-delirium (25). During surgery and anesthesia, more than 65% of children experience intense anxiety and fear. Among the newly developed maladaptive behavior changes are widespread anxiety, night crying, enuresis, separation anxiety, and temper tantrums. These findings are seen in 50% of the children who have had surgery (26). According to Kain et al. increase preoperative anxiety levels are associated with an increased incidence of postoperative behavioral disorders (27). Postoperative anxiety can cause social problems by preventing patients from participating in physical activities such as games and sports. This situation has a negative impact on the child's physical and mental development. For all of these psychological and social reasons, surgery in childrem should be avoided if at all possible. Although it is understood that the events will not be remembered precisely, it was observed that patients in this age group were protected from the aforementioned potential adverse conditions following surgery, in face-to-face interviews with the family in the first year using the polyclinic cards (Table 3).

Another limitation of this study is the small sample size. Multi-center studies with a larger sample size are required to confirm our findings and further establish conservative management selection criteria across different hospitals in order to prevent poor outcomes in PEDH.

Conclusion

The study attempted to demonstrate that in PEDH cases, a patient-based treatment decision can be made by combining clinical and radiological findings. It also demonstrated that conservative treatment with good follow-up can be used in patients with early admission and multilobar large PEDH. We believe that conservative treatment with an experienced team in fully equipped facilities may be a viable option. Furthermore, the study emphasized that surgeons should consider the possibility of a socio-cultural influence on children who have undergone surgery in their future lives.

Conflict of Interest: The authors declare no conflict of interest regarding this study.

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Authors' Contributions: R.A. and U.S. wrote the article. R.A. conceived the idea. R.A. and U.S.collected data. R.A. analyzed data. U.A. assisted with study design and revised the article. All authors have read and approved the final manuscript.

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