

A series of post-traumatic midline epidural hematoma and review of the literature

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ABSTRACT

BACKGROUND: Supratentorial midline epidural hematoma is rare but challenging in diagnosis and management. Indication for surgery can arise even following hospital admission. Being familiar to the presentation and watching out for direct and indirect signs on axial computed tomography (CT) such as suture diastasis or fracture traversing midline are essential to plan multi-planar CT enabling exact diagnosis including form and mass effect of hematoma.

METHODS: Nine patients with midline epidural hematoma including two pediatric patients underwent surgery between 2013 and 2018. Pre-operative and post-operative patient status, radiological features, and surgical technique were analyzed.

RESULTS: Four patients had deteriorating consciousness levels and two patients had paraparesis. All had fractures traversing midline and epidural hematomas with significant mass effect. They were operated through separated craniotomies around the midline and midline bone strip was used for dural tenting and as support for natural closure of bone flaps. No post-operative complications were developed. All patients were discharged with Glasgow Outcome Score of 5.

CONCLUSION: Because of the rarity of the lesion and small number of patients, definitive conclusions may be misleading but we think that, in experienced hands, midline epidural hematomas can safely be operated on and, preservation of midline bone strip provides easier bleeding control.

Keywords: Epidural hematoma; midline hematoma; sagittal sinus; vertex.

INTRODUCTION

Supratentorial epidural hematomas are rarely observed in the midline with an approximate rate of 0.024% for all head traumas and they constitute 1–8% of all epidural hematomas.^[1,2] Generally called also vertex epidural hematomas, midline epidural hematomas have diagnostic and surgical difficulties due to its pathogenesis and location. They show a variety of symptoms such as paraparesis because of mass effect to the bilateral motor area and intracranial hypertension due to im-

pairment of flow in arachnoid granulations and superior sagittal sinus.^[2–4] It has been mostly reported that injury of superior sagittal sinus is the source of bleeding.^[1,2,5] Furthermore, there are reports that do not indicate any dural sinus tear or arterial injury observed during evacuation of hematoma.^[6]

In addition to unusual clinical picture, one easily can fail these cases to diagnose on routine axial computed tomography (CT) scans. Multiplanar imaging methods make the diagnosis quick and easy. Midline epidural hematoma is an entity that

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requires rapid diagnosis and management decision. Otherwise, mortality rate is 18–50% in cases with delayed treatment.^[7]

In this clinical study, we investigated the clinical and radiological features of nine patients we operated for midline epidural hematomas, together with surgical technique and clinical outcome.

MATERIALS AND METHODS

A retrospective analysis was performed on patients with midline epidural hematoma who were treated at the neurosurgery department of Bakirkoy Sadi Konuk Research and Training Hospital, University of Health Sciences between 2013 and 2018. Patient characteristics, their neurological findings at admission, additional injuries, radiological features, surgical technique, and outcome were recorded.

At the admission, we performed multiplanar CT scan for all patients to elicit intracranial injury as initial radiological examination after clinical examination. After the diagnosis of midline epidural hematoma was made, an operation for evacuation was planned for all patients using separated craniotomies.

Patients' head were fixed in three pin holder in supine position and elevated for 30°. This position was found to be favorable against air embolism in surgeon's experience. A bicoronal incision was made and fracture line identified. Two separate craniotomy flaps on each hemisphere were performed covering whole margins of hematoma and leaving a 3 cm wide bone strip over sagittal sinus (Fig. 1). Following epidural clot removal, source of bleeding was revealed. In all



Figure 1. Epidural exploration with separated craniotomies. The depressed occipital fracture and epidural space after evacuation and bleeding control appear preoperatively. Midline bone strip was preserved with separated craniotomies and planned to prepare as a roof for tenting sutures to provide further bleeding control and prevent rebleeding in the postoperative period.

cases, the source was a tear in the wall of superior sagittal sinus or arachnoid granulation. Hemostatic gelatin sponge strip was placed over the tear and dural tenting sutures were placed along the bone strip and craniotomy borders. Subdural space was controlled for any accompanying subdural hematoma through a small dural incision. Craniotomy flaps were replaced along with epidural and subgaleal drains.

In post-operative period, we evaluate patients routinely with multiplanar CT. In addition, we executed cranial magnetic resonance (MR) and MR venography in three patients to demonstrate the flow in superior sagittal sinus in the late period. The neurological status of the patients at discharge was assessed with Glasgow Outcome Score (GOS).

RESULTS

Nine patients with midline epidural hematoma underwent emergency surgery. There were seven male and two female patients. Patients' age ranged from 11 to 64 years (32.9±18.3). Two patients were under 18 years old.

All patients were admitted to emergency room shortly after trauma (40–120 min). Two patients were admitted to emergency room with the history of falling from height, four patients with road traffic accident and three patients with assault. All signs and symptoms had acute onset and were found on initial examination excepting in one patient who had lucid interval. Four patients were presented with deteriorated level of consciousness such as one with a Glasgow Coma Score (GCS) of 8, one with a GCS of 12 and two with a GCS of 14. One patient having a GCS of 14 and one patient having a GCS of 15 had paraparesis. The patient who presented paraparesis with a GCS of 15 had lucid interval before presentation of increased ICP findings such as disorientation and neurological deficit. Patients without any neurological deficits complained about severe headache, nausea, and vomiting (Table 1). We observed post-traumatic retrograde amnesia in three of these patients. Furthermore, there were four patients who had traumatic lesions in other systems such as lung contusions, abdominal injury, and multiple fractures.

In the pre-operative radiological assessment, fracture line traversing midline was shown in all patients. All epidural hematomas had thickness of more than 2 cm with a significant mass effect on the underlying dura, sinus, and parenchyma (Fig. 2). In addition to mass effect of midline epidural hematoma, contusion, and subarachnoid hemorrhage were observed as an evidence of severe head trauma and a possible contributing reason of the altered consciousness level in three patients having a GCS of 8, 12, and 14.

In all these patients who were operated for evacuation of epidural hematoma, the sinus wall tear was located on the anterior third in two patients, middle third in five patients, and posterior third in two patients. After surgery, no addi-

Table 1. Patients' characteristics and outcome

Age	Sex	Mode of injury	GCS at admission	Injury location on SSS	Location of hematoma	Thickness of hematoma (cm)	Increased ICP findings	Additional ICH	Multiple trauma	Hospital stay (days)	GOS
58	M	Falling	15	Posterior third	Frontoparietal	3.5	N/V, disorientation, paraparesis	-	-	7	5
11	M	Falling	15	Anterior third	Frontal	2.4	Headache, N/V	-	-	6	5
16	F	RTA	8	Middle third	Frontoparietal	3.2	Altered level of consciousness	Contusion	Multiple fractures and lung contusion	33	5
24	M	Assault	15	Middle third	Frontoparietal	2.1	Headache, N/V	-	-	8	5
29	M	Assault	15	Middle third	Frontoparietal	2.3	Headache	-	Abdominal injury	7	5
41	M	RTA	14	Middle third	Frontoparietal	2.4	Headache, disorientation, paraparesis	Contusion	-	9	5
32	M	RTA	15	Middle third	Frontoparietal	2.3	Headache, N/V	-	-	6	5
64	M	Assault	12	Anterior third	Frontal	2.7	Altered level of consciousness	SAH	Multiple fractures	12	5
21	F	RTA	14	Posterior third	Parietooccipital	2.2	Headache, N/V, disorientation	-	Extremity and pelvic fractures	14	5

ICH: Intracranial hemorrhage; SAH: Subarachnoid hemorrhage; N/V: Nausea and vomiting; RTA: Road traffic accident; M: Male; F: Female.

tional neurologic deficit was observed and no de novo hemorrhage in the operational site was identified with multiplanar CT in any patients in the post-operative period. In three patients who are executed post-operative cranial MR imaging (MRI) and MR venography, venous flow was observed intact in superior sagittal sinus (Fig. 3). The duration of hospitalization was between 6 and 33 days. All patients had GOS of five at discharge.

DISCUSSION

Epidural hematomas are generally originated from injury to the middle meningeal artery or its branches by fracture lines after head trauma. In these cases, the lateral convexity is the usual location of hematoma.^[8] Posterior fossa and supratentorial midline are infrequent locations.^[9] In contrast to epidural hematomas of the convexity, midline epidural hematomas are associated with both supratentorial hemispheric surface and superior sagittal sinus, one of the most vital drainage structures of the brain. Their incidence is about 1–8% of all epidural hematomas.^[1,2]

Supratentorial midline epidural hematomas might be classified according to their location. Bifrontal hematomas are located over anterior third of superior sagittal sinus, vertex hematomas over middle third, and bioccipital hematomas over posterior third.^[2,5,10]

Patients with midline epidural hematomas may present in different clinical pictures. Elevated intracranial pressure (ICP) due to mass effect, obliteration of sagittal sinus by hematoma or injury of dural sinus and drainage veins can cause several neurological signs or these signs can be solely depending on the size and location of hematoma.^[2] Severe headache should be regarded as a major symptom for midline hematomas. As noted by Columella et al.^[11] and Wylen, dural irritation around sinus wall containing rich sensorial fibers or increased ICP due to collapsed dural sinus flow could cause severe headache.^[1] Increased ICP also might cause visual impairment and papilledema.^[7,11] Cranial nerve involvement is unusual but reported. Bilateral abducent nerve palsy was observed in a couple of cases and unilateral oculomotor nerve palsy was observed in another case.^[3,12,13] Unilateral or bilateral lower extremity weakness is considered as a result of pressure on parasagittal motor cortex.^[1,3,14] Upper

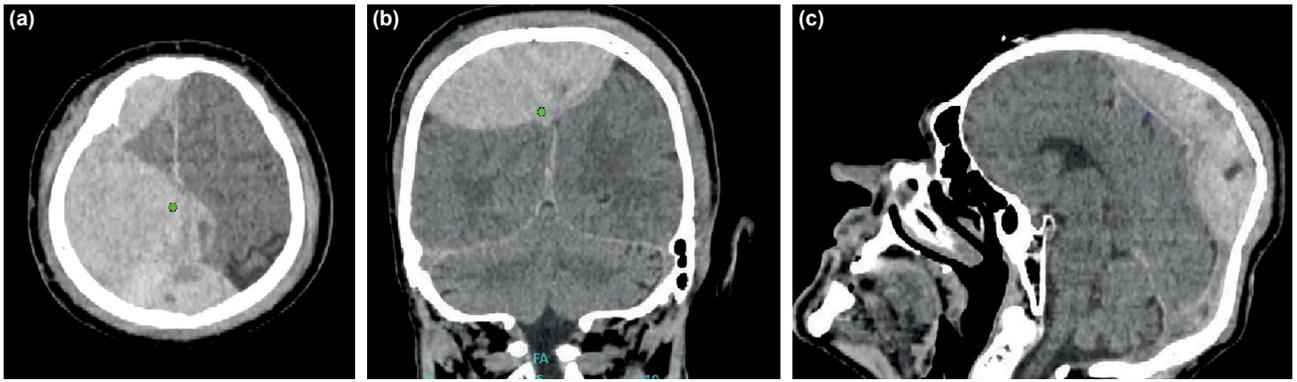


Figure 2. 58-year-old male patient was admitted to the hospital with a Glasgow Coma Score of 15 and operated due to deterioration of consciousness and paraparesis developing during follow-up. Axial (a), coronal (b) and sagittal plan (c) computed tomography imaging of patient shows a huge epidural hematoma extending both sides of convexity with mass effect on parenchyma and depressed occipital fracture.

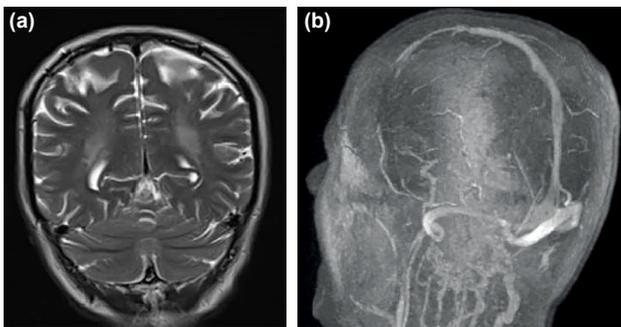


Figure 3. Late period postoperative T2-sequence coronal plan cranial magnetic resonance (MR) (a) and MR venography (b) of 58 years old patient. Superior sagittal sinus without flow impairment after surgical intervention.

extremity weakness or hemiparesis may also be present.^[3,15] Pathogenesis of this symptom, whether it is caused by mass effect on motor cortex or downward transtentorial herniation, is controversial. Neurological symptom and signs may develop very fast or in the course of hours or even days. Moreover, chronic cases presenting neurological symptoms and requiring surgical intervention have been reported.^[16,17] In our patients, the major symptoms were severe headache, nausea, and vomiting with acute onset. Of the patients, three had shown retrograde amnesia. In the neurological examination, two patients revealed altered level of consciousness being lower than a GCS of 13 and two patients had paraparesis.

In patients with normal neurological examination, diagnosis may occasionally present a problem. A linear fracture that traverses the midline, or coronal or sagittal suture diastasis should be alerting signs for midline epidural hematoma.^[1,4,14,18] In a report presented by Nayil et al.,^[13] it was mentioned that a patient who had a traffic accident underwent radiological assessment and was diagnosed a fracture line lying throughout bilateral parietal bone. In addition, hyperdensity in high axial midline sections was demonstrated but misinterpreted as artifact. A few days later, patient had neurological signs indicating elevated ICP and underwent surgery for evacua-

tion of midline epidural hematoma. In another report, Jones presented a case with vertex epidural hematoma accompanying slightly depressed skull fracture located in the midline.^[5] Borzone et al.^[19] and Zucarello et al.^[20] reported that all vertex epidural hematomas were associated with fractures traversing sagittal suture in their series. In a radiological study, Harbury et al.^[21] reported two patients with vertex epidural hematoma occurred after head trauma. Epidural hematomas accompanied a fracture line traversing sagittal suture in one patient and a fracture line located at high parietal bone in another. In our series, all patients also had fractures traversing midline. If CT scans are only viewed on axial plane, some horizontal fractures or small midline hematomas may be overseen. Today, multiplanar CT scan should always be considered in the trauma setting not to miss a slight midline hematoma that may enlarge.^[2,21]

MRI is a radiologically superior option to scan and determine the volume of hematoma, mass effect on parenchyma, and superior sagittal sinus displacement.^[21,22] Furthermore, MR venography may reveal the condition of sagittal sinus. Harbury et al.^[21] radiologically evaluated a patient who had surgery for meningioma. Cranial MR and MR venography demonstrated integrity of the sinus and mass effect of the epidural hematoma under craniotomy site on parenchyma and superior sagittal sinus. Similarly, Server showed the sinus displacement due to traumatic midline epidural hematoma preoperatively through MR venography in their case.^[22] But MRI is still not preferred as an emergency procedure because of higher cost and longer scanning time. In our series, we evaluated the post-operative condition of the sinus and we showed intact flow in the sinus with MR venography in three patients (not in all patients and due to technical problems).

Laceration of superior sagittal sinus wall or tear of arachnoid granulation has been implicated as bleeding source in most reports in the literature.^[1,2,5,8,9,19,20,23] Although observed less often, other etiologies have been reported so far. Columella

et al.^[11] mentioned oozing from fracture line and detachment of dura from bone as bleeding source. Ramesh^[24] referred to a traumatic case with Paget's disease in the absence of fracture or dural sinus injury. In a similar way of majority, we observed tear of sinus wall or arachnoid granulation as bleeding source. Adding to the fracture form, this is the most important anticipation forming the surgical strategy. We wanted to define our approach to provide a faster and easier way of hemostasis and as long as the fracture form does not need to surgically reform or manage to reshape without removing the bone fragments at least, we were intended to operate by leaving bone strip on the sinus.

No standard treatment algorithm has been widely accepted for midline epidural hematomas. Conservative treatment was preferred in some cases even if the patients were neurologically compromised or there was significant mass effect on CT scans.^[7,12,25,26] In addition to surgical difficulties including high mortality risk, unpredictable nature of this entity may complicate to make a decision about surgical need.^[18] In case of nonsurgical decision, close follow-up is essential and it should be kept in mind that neurological worsening may be quick and irreversible. On the other hand, need of evacuation may arise due to neurological worsening in the long-term period even after a reasonable time of monitoring.^[16,17,27] In all of our patients, we preferred to perform surgical evacuation due to the signs indicating increased ICP. All patients did well after surgery and were discharged with good outcome status. Our positive experience on behalf of evacuation sets us thinking surgery rather than conservative management in the presence of neurological signs and considerable mass effect.

Different surgical techniques have been suggested in English literature. One of the main controversies is keeping a midline bone strip during craniotomy. Patients who were operated with a single craniotomy are reported to have good outcomes generally.^[6,7,13,17,26,28,29] This approach may be a good option especially for cases with concomitant fragmented skull fractures or in need of direct access to sinus for bleeding control and direct repair. In need of sinus repair, several techniques could be executed. Sinoraphy with or without fascia graft is one of the most preferable way to repair the sinus wall.^[26,30,31] A peduncle of adjacent dura may use as cover by rolling and stitching over the sinus. Clipping the lateral sinus angle or ligation of the distal part of injury should be performed cautiously.^[31] In another report, surgeons chose not to expose the sinus by leaving a thin layer of clot to avoid bleeding.^[7] There are other surgeons that advocate that complete exposure of sinus could cause further tearing of the wall and air embolism. Preserving a midline bone strip gives a back-up for dural tenting sutures both to provide hemostasis preoperatively and to prevent post-operative reaccumulation of blood, especially in cases with thick epidural hematomas.^[32,33] There are many reports with successful results using separated craniotomy technique without unplanned further interventions.^[5,9,27,32,33]

Placing of hemostatic gelatin sponge on the sinus and dural tenting sutures to the margins of bone strip between craniotomies was sufficed to control bleeding in our nine cases and we did not need additional direct sinus repair.

If not otherwise required, leaving a bone strip seems to be the right choice. Even so the methods of dural sinus repair are well-defined at the present time,^[30,31] we think that making a single craniotomy should be avoided because midline bone strip rules out the need for any additional method and prevent loss of time for bleeding control. Furthermore, a natural frame is maintained for more natural bony structure after closure of craniotomy flap and a sufficient area is provided for decompression and proper evacuation. Also, the bone strip may be preoperatively decided to be removed in any case if direct sinus repair is inevitable.^[32,33] This surgical technique is not only recommended for supratentorial midline hematomas but also any traumatic injuries crossing over major dural sinuses. Lapadula et al.^[9] and Aggarwal et al.^[34] reported this method for posterior fossa hematomas extending to the supratentorial area. It is reported that a patient operated for bilateral temporo-occipital epidural hematoma abutting on transvers sinuses and it was preferred to use a four-parted craniotomy leaving a cross-shaped bone strip over posterior part of superior sagittal sinus, bilateral transvers sinus, occipital sinus, and the confluence.^[34] Lapadula et al.^[9] was also stated a case operated for left cerebellar extradural hematoma extending supratentorial region. In this case, a three-parted craniotomy was executed to prevent bone strips upon the posterior part of superior sagittal sinus, transvers sinuses and the confluence. It is referred the benefits on easier hemostasis and saving of operational time in both reports.^[9,34]

Conclusion

Supratentorial midline hematomas may cause difficulties to physicians diagnosing and managing trauma cases. The prominent factor is accurate and punctual detection of hematoma to decrease mortality rate. Follow-up decision should only be made under close follow-up. If needed, surgery, through separate craniotomies around the midline, is a safe and reliable technique with good postoperative results, also preventing postoperative recollection of hematoma.

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ORIJİNAL ÇALIŞMA - ÖZ

Posttravmatik orta hat epidural hematoma serisi ve literatür derlemesi

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AMAÇ: Supratentoryal orta hat epidural hematomları nadir görülmesinin yanı sıra tanıda ve yönetimde zorludur. Ameliyat gerekliliği hastane takibinin ardından dahi oluşabilir. Klinik semptomlara aşına olmak ve aksiyel bilgisayarlı tomografi (BT) incelemesinde doğrudan kanama bulgularına ya da sütür diastazi ve orta hattı çaprazlayan kırıklar gibi dolaylı bulgulara dikkat etmek, hematomun formu ve kitle etkisi ile birlikte kesin tanısını sağlayan çoklu plan BT çekimi planlamak için gereklidir.

GEREÇ VE YÖNTEM: İki pediatrik hasta olmak üzere orta hat epidural hematoma tanılı toplam dokuz hasta 2013 ve 2018 yılları arasında ameliyat edildi. Hastaların ameliyat öncesi ve sonrası durumları, radyolojik bulguları ve uygulanan cerrahi teknik değerlendirildi.

BULGULAR: Dört hastanın azalmış bilinç düzeyi ve iki hastanın paraparezi bulgusu mevcuttu. Bütün hastalarda orta hattı çaprazlayan kırık ve kitle etkisi gösteren epidural hematoma saptandı. Bütün hastalar orta hattın iki yanına ayrı kranyotomi açılarak ameliyat edildi ve orta hatta bırakılan kemik şerit durayı asmak ve kemik fleplerinde kapatılmasında destek amacıyla kullanıldı. Ameliyat sonrası dönemde komplikasyon görülmedi. Tüm hastalar GOS değeri 5 ile taburcu edildi.

TARTIŞMA: Bu lezyonların nadir görülmesi ve hasta sayısının azlığı nedeniyle kesin sonuç çıkarmak yanıltıcı olabilir ancak tecrübeli ellerde orta hat epidural hematomu güvenle ameliyat edilebileceğini ve orta hatta kemik şeridin korunması ile daha kolay kanama kontrolü sağlanabileceğini düşünüyoruz.

Anahtar sözcükler: Epidural hematoma; orta hat hematomu; sığital sinüs; verteks.

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