The Journal of Emergency Medicine, Vol. ■, No. ■, pp. 1–4, 2022

0736-4679/$ - see front matter

ELSEVIER

https://doi.org/10.1016/j.jemermed.2022.06.012

Clinical Communications: Pediatric

Complete Neurological Recovery After Emergency Burr Hole Placement Utilizing EZ-IO® for Epidural Hematoma

Marc Grossman,* Alfred P. See,†,‡ Rebekya Mannix,‡,§ and Erin L. Simon||,¶

*Department of Emergency Medicine, Parkland Medical Center, Derry, New Hampshire, †Department of Neurosurgery, Boston Children's Hospital, Boston, Massachusetts, ‡Harvard Medical School, Boston, Massachusetts, §Division of Emergency Medicine, Boston Children's Hospital, Boston, Massachusetts, ||Department of Emergency Medicine, Cleveland Clinic Akron General, Akron, Ohio, and ¶Northeast Ohio Medical University, Rootstown, Ohio

Reprint Address: Erin Simon, DO, Department of Emergency Medicine, Cleveland Clinic Akron General, 1 Akron General Avenue, Akron, OH 44307.

☐ **Abstract—Background: Post-traumatic epidural hematoma (EDH) accounts for 1–3% of pediatric closed head injury admissions. There is a 2.5:1 male predominance. Etiology varies by age; motor vehicle collisions are the primary cause of EDH in adolescents. Post-traumatic EDH accompanies up to 4% of adult head injuries, and is associated with 10% mortality in adults and 5% mortality in children. In North America, standard of care for post-traumatic EDH includes decompressive craniotomy or trepanation via burr hole. Such lifesaving care is typically provided in the operating room by consulting neurosurgery teams or other personnel trained in the use of burr hole equipment. Case Report: The case of a 17-year-old female patient who presented to a community emergency department (ED) after being involved in a motor vehicle collision is discussed. At the scene of the accident, she refused emergency medical services transport and was brought to the ED via private vehicle. She quickly decompensated in the ED and required intubation. Neurosurgical services were not available and transport to the nearest pediatric trauma center was delayed due to weather. Decompression and drainage of her EDH was accomplished with an EZ-IO® driver and intraosseous needle under virtual guidance of a pediatric neurosurgeon until definitive care could be obtained. The patient made a full neurologic recovery. Why Should an Emergency Physician Be Aware of This: EDHs have high morbidity and mortality. In settings without access to neurosurgical services, and where ED access to or familiarity with burr hole equipment is limited, the EZ-IO® device may be a temporizing and lifesaving intervention until definitive neurosurgical care can be obtained. © 2022 Elsevier Inc. All rights reserved.**

☐ **Keywords—epidural hematoma; intraosseous; burr hole; EZ-IO®**

Introduction

An epidural hematoma (EDH) can be arterial or venous in origin. The classic arterial EDH in adults occurs after blunt trauma to the head, most often in the temporal region. The most common locations of EDH in pediatrics are frontal, parietooccipital, and posterior fossa. There is decreased incidence of purely temporal EDH in pediatrics because the middle meningeal artery is not indented into the temporal bone as often as in adults (1).

Frequently, a skull fracture damages the middle meningeal artery causing arterial bleeding into the epidural space. Approximately 85–95% of EDHs have an overlying skull fracture. Although the middle meningeal artery is the most commonly injured artery, any meningeal artery can lead to an arterial EDH (2). EDHs are present in up to 4% of patients with traumatic head injury and account for 5–15% of fatal head injuries. In the adolescent

Received: 20 April 2022; Accepted: 4 June 2022

years, motor vehicle collisions are the primary cause of EDHs (1).

Patients with an EDH may report a history of localized head injury, such as blunt trauma from an object, fall, or motor vehicle collision. The classic presentation of an EDH is a loss of consciousness after the injury, followed by a lucid interval, then neurologic deterioration (3). This occurs in $<$ 20% of patients. Other common symptoms include severe headache, nausea, vomiting, lethargy, and seizure (4).

Acute symptomatic EDH is a neurologic emergency and immediate neurosurgical consultation should be obtained. EDHs may expand over time due to continued bleeding, and prompt treatment prevents irreversible brain injury and death caused by elevated intracranial pressure and brain herniation. Definitive treatment of symptomatic EDH is craniotomy and evacuation of the hematoma. When indicated, identification and ligation of the bleeding vessel must be undertaken. Burr hole evacuation has been used for acute EDH, and may be lifesaving if access to neurosurgical expertise is limited or delayed (5). Smaller EDHs may be managed nonsurgically and watched closely for resolution.

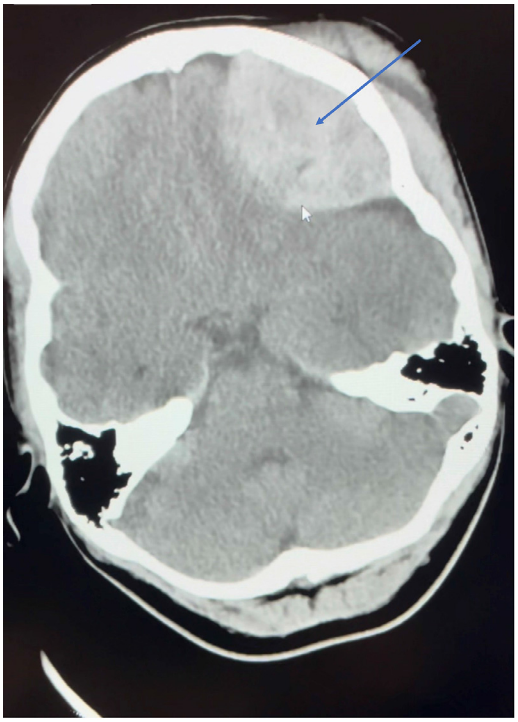

Figure 1. Computed tomography showing a left frontal epidural hematoma.

Case Report

A 17-year-old girl, who was an unrestrained passenger in a motor vehicle accident, arrived to the emergency department (ED) via private automobile after she had refused emergency medical service assistance and transport on scene. The patient had a brief loss of consciousness, then awoke and was later brought to the ED by a friend. Shortly after ED arrival, she collapsed, had an episode of emesis, and again went unresponsive. Vital signs were blood pressure 123/74 mm Hg, respirations 24 breaths/min, heart rate 102 beats/min, oxygen saturation 97% on room air, and a Glasgow Coma Scale (GCS) score of 4. Physical examination revealed a left enlarged, nonreactive pupil, large left frontal hematoma above the eyebrow, active emesis, and she was responsive to deep pain only, with a nonfocal neurologic examination. Computed tomography (CT) of the head revealed a frontotemporal EDH with 1.5-cm thickness causing 7 mm of midline shift without uncal herniation (Figure 1).

Transfer to a higher level of care for definitive neurosurgical intervention was attempted, however, inclement weather did not allow for air transport and ground transport was delayed. Given the delay in transport, telephone consultation with pediatric neurosurgery at a level I pediatric trauma center was initiated. There was no immediate availability of cranial burr hole equipment at the community ED, however, the EZ-IO® intraosseous device was readily available. After discussion regarding utilization of an intraosseous needle for trepanation and review of imaging with pediatric neurosurgery, a safe trajectory that would avoid the orbit, frontal sinus, and Sylvian fissure was identified. The patient was then intubated for airway protection, hyperventilated, and the head of the bed was elevated. The patient was placed on mannitol at 100 g and a propofol drip was utilized for sedation. The target area to drain the frontal EDH was marked and the patient was prepped and draped in standard sterile fashion. An intraosseous insertion driver and needle (EZ-IO®; length 25 mm, 15 gauge) was used to access the EDH (Figure 2). Once bone fenestration was complete, 35 mL of blood was withdrawn via syringe. The patient improved rapidly after the removal of blood and, while sedated and intubated, her GCS improved to 8. However, a repeat head CT revealed re-accumulation of the hematoma despite correct placement of the intraosseous needle. Radiology reported a "stable large left frontotemporal epidural hematoma with approximately 8 mm of anterior midline shift. Tip of drainage catheter seen within the frontal epidural hematoma." Transport was then initiated to a level I pediatric trauma center, where the remaining hematoma was evacuated. The patient was extubated on postoperative day (POD) 1, and discharged to home on POD 4, without neurologic deficit.

Please cite this article as: M. Grossman et al., Emergency Burr Hole Placement, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.06.012

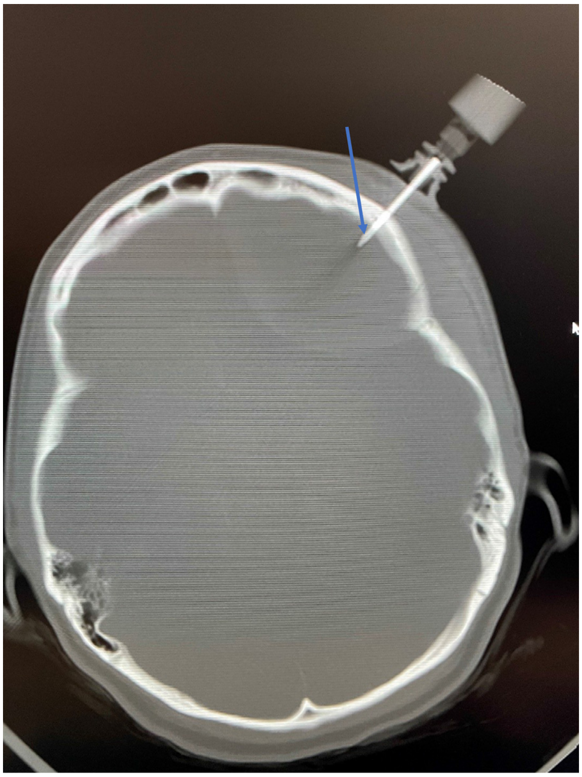

Figure 2. Computed tomography showing placement of emergent burr hole utilizing the EZ-IO® (arrow) into the left epidural hematoma.

Discussion

Prior case reports have reported on utilization of an intraosseous device with varying neurological recovery. In a study by Bulstrode et al., a 43-year-old woman was a pedestrian struck by a car. She deteriorated in the ED and an EZ-IO® device was utilized and 30 mL of blood was aspirated in 8 min. She recovered fully without neurologic deficit (6). Another case involved a 69-year-old man with a post-traumatic EDH from a closed head injury. His GCS went from 14 to 3 and an intraosseous device was inserted and aspirated 70 mL of blood over 10 min. The patient expired after neurosurgery (7). Another case was a 38-year-old man with new-onset seizure with a fall and closed head injury who had a history of glioblastoma multiforme and prior craniotomy. He had a large post-traumatic EDH and an intraosseous device was utilized and 80 mL of blood was aspirated. Repeat head CT confirmed proper placement and an additional 150 mL was aspirated. He died after neurosurgical intervention (8). Finally, in a case series that included a 65-year-old man and a 30-year-old man, an intraosseous device was utilized for both patients; the 65-year-old man died and the 30-year-old man survived with no neurologic recovery (9). In a recent pilot study utilizing cadavers, an EZ-IO® device was used to explore ideal needle length for emergency burr holes in the ED. They compared the 15-mm needle with the 25-mm needle, but determined that the ideal needle length was difficult to ascertain. They found that the 25-mm needle consistently penetrated the inner table of the skull, and depths ranged from 8 to 14 mm. The 15-mm needle had several instances when the skin was intact where it did not penetrate the inner table of the skull and when it did, depths were 0.5–1 mm. With skin removed using the 15-mm needle, there was consistent inner table skull penetration with depths of 3–9.5 mm. Therefore, the 15-mm needle with a skin cutdown may be ideal (10).

Early post-traumatic EDH evacuation has shown a reduction in mortality from 56% (if untreated or if treatment is delayed) to 17% (11). EDH is a neurosurgical emergency that often requires surgical evacuation to prevent irreversible neurologic injury and death secondary to hematoma expansion and herniation. Neurosurgical consultation should be obtained promptly, as it is important to intervene within 1–2 h of presentation (11–14). Intervention after 2 h increases mortality 65%, with only 13% having good neurologic recovery (11). Traditional signs and symptoms of increased intracranial pressure are not always present in EDH and should not be relied on when determining treatment course (15).

In circumstances when transport is not readily available and the patient presents to a facility without emergency neurosurgical coverage, utilizing an intraosseous device could be potentially lifesaving until the patient can be transported for definitive neurosurgical operative intervention. The trajectory of the intraosseous needle is of primary importance to avoid globe injury, vascular injury, and to reduce infection risk. Our experience with trepanation by an emergency physician with the use of a widely available intraosseous device, underscores an opportunity for post-traumatic EDH management in the community ED setting until transport and intervention by neurosurgery are available.

Why Should an Emergency Physician Be Aware of This?

EDHs are seen in up to 4% of post-traumatic head injuries and have high morbidity and mortality. In settings without access to neurosurgical services, and where ED access to or familiarity with burr hole equipment is limited, the EZ-IO® device may be a temporizing and lifesaving intervention until definitive neurosurgical care can be obtained.

Please cite this article as: M. Grossman et al., Emergency Burr Hole Placement, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.06.012

References

1. Rocchi G, Caroli E, Raco A, Salvati M, Delfini R. Traumatic epidural hematoma in children. J Child Neurol 2005;20:569–72.
2. Babu JM, Patel SA, Palumbo MA, Daniels AH. Spinal emergencies in primary care practice. Am J Med 2019;132:300–6.
3. Ganz JC. The lucid interval associated with epidural bleeding: evolving understanding. J Neurosurg 2013;118:739–45.
4. Bullock MR, Chesnut R, Ghajar J, et al. Surgical management of acute epidural hematomas. Neurosurgery 2006;58(3 suppl):S7–15 discussion Si–iv.
5. Nelson JA. Local skull trephination before transfer is associated with favorable outcomes in cerebral herniation from epidural hematoma. Acad Emerg Med 2011;18:78–85.
6. Bulstrode H, Kabwama S, Durnford A, Hempenstall J, Chakraborty A. Temporising extradural haematoma by craniostomy using an intraosseous needle. Injury 2017;48:1098–100.
7. Durnford S, Bulstrode H, Durnford A, Chakraborty A, Tarmey NT. Temporising an extradural haematoma by intraosseous needle craniostomy in the District General Hospital by non-neurosurgical doctors - a case report. J Intensive Care Soc 2018;19:76–9.
8. McClung CD, Anshus JS, Anshus AJ, Baker SR. Bedside craniostomy and serial aspiration with an intraosseous drill/needle to temporize an acute epidural hemorrhage with mass effect. World Neurosurg 2020;142:218–21.
9. Barro B, Kobner S, Ansari A. Decompression of subdural hematomas using an intraosseous needle in the emergency department: a case series. Clin Pract Cases Emerg Med 2020;4: 312–315.
10. Gustafson ML, Edwards J, Tager A. Emergency burr hole utilizing the EZ-IO™ drill: a pilot cadaver study. Am J Emerg Med 2021;39:229–30.
11. Haselsberger K, Pucher R, Auer LM. Prognosis after acute subdural or epidural haemorrhage. Acta Neurochir (Wien) 1988;90(3–4):111–16.
12. Bhorkar NM, Dhansura TS, Tarawade UB, Mehta SS. Epidural hematoma: vigilance beyond guidelines. Indian J Crit Care Med 2018;22:555–7.
13. Gutowski P, Meier U, Rohde V, Lemcke J, von der Brelie C. Clinical outcome of epidural hematoma treated surgically in the era of modern resuscitation and trauma care. World Neurosurg 2018;118:e166–74.
14. Basamh M, Robert A, Lamoureux J, Saluja RS, Marcoux J. Epidural hematoma treated conservatively: when to expect the worst. Can J Neurol Sci 2016;43:74–81.
15. Ter Avest E, Taylor S, Wilson M, Lyon RL. Prehospital clinical signs are a poor predictor of raised intracranial pressure following traumatic brain injury. Emerg Med J 2021;38:21–6.

Please cite this article as: M. Grossman et al., Emergency Burr Hole Placement, Journal of Emergency Medicine, https://doi.org/10.1016/j.jemermed.2022.06.012