AANHS Journal
Journal homepage: http://aanhsj.usu.ac.id

Theoretical Approach to the Management of Epidural Hematoma (EDH): Optimal Timing for Surgical Intervention

Muhammad Hafzul Fauzy*[1], Diwa Auliya Ahmad[2],
[1] *Department of Neurosurgery Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia*
[2] *General Practitioner, Universitas Sumatera Utara, Medan, Indonesia*
*Corresponding author: hafzul27@gmail.com

ARTICLE INFO

Article history:
Received : Apr, 09th 2025
Revised : Apr, 26th 2025
Accepted : Apr, 27th 2025
Available: Apr, 30th2025

E-ISSN: 2686-0848

How to cite:
Fauzy MH, Ahmad DA. Theoretical Approach to the Management of Epidural Hematoma (EDH): Optimal Timing for Surgical Intervention. Asian Australasian Neuro and Health Science Journal. 2025 Apr 07(01):20-26

DOI: 10.32734/aanhsj.v7i01.20428

ABSTRACT

Introduction: Epidural hematoma (EDH) is a life-threatening condition that requires timely surgical intervention to prevent irreversible neurological damage, with early decompression within the "golden hour" being critical for better outcomes.

Case Description: Two cases were discussed: Case 1, an 81-year-old female who underwent surgery within 12 hours with significant recovery, and Case 2, a 73-year-old male who showed deterioration after delayed intervention but improved following decompression within 12 hours.

Discussion: Early surgical intervention prevents brain herniation and secondary brain injury. The "golden hour" concept emphasizes decompression within hours of symptom onset. Access to timely care in rural settings can delay intervention, worsening outcomes. The timing of surgery must consider individual patient factors, such as comorbidities and hematoma size.

Conclusion: Optimal surgical timing, especially within the "golden hour," is critical in EDH management to prevent irreversible neurological damage. Individualized treatment plans should account for access to care and patient-specific factors for the best outcomes.

Keyword: Epidural Hematoma; Surgical Intervention; Golden Hour; Neurological Recovery.

1. Introduction

Epidural hematoma (EDH) is a critical and rapidly evolving condition that often requires urgent surgical intervention to prevent irreversible brain damage. As described in the cases above, the pathophysiology of EDH is closely related to intracranial pressure (ICP) dynamics, with hematoma accumulation leading to an increase in ICP. This rise in pressure can cause brain herniation, a life-threatening condition that necessitates immediate intervention to relieve the pressure and avoid permanent neurological deficits. The decision regarding the optimal timing for surgical evacuation of an EDH is crucial, as delays can worsen outcomes significantly due to increased risks of brain herniation and further deterioration of neurological function.[1, 2]

The concept of the "golden hour," the critical period following traumatic brain injury within which surgical intervention is most beneficial, plays a central role in managing EDH. Prompt decompression within this window has been shown to improve patient outcomes by preventing

secondary brain injury. As seen in the case series presented, early surgical intervention (within 12 hours of symptom onset) resulted in favorable neurological recovery, supporting the notion that timely evacuation of the hematoma is paramount. A delay in surgery, on the other hand, can lead to irreversible complications, including neurological impairment or death, especially when the hematoma exceeds certain thresholds (e.g., volume greater than 30 cm^3 or midline shift exceeding 5mm).[1, 2]

In practice, there are challenges to maintaining this "golden hour" in certain clinical settings. In rural or resource-limited environments, where access to neurosurgical facilities may be delayed, the decision-making process becomes more complex. As demonstrated in the second case, the patient's presentation with initial stable neurological function but subsequent deterioration emphasizes the need for careful monitoring and timely imaging to detect evolving neurological compromise. This is particularly critical in the context of patients with limited access to emergency surgical care, where a delay could significantly alter the prognosis.[2, 3]

Management of EDH should be based on an understanding of ICP physiology and the risks associated with delayed intervention. The evidence suggests that surgical decompression should be performed as early as possible to minimize the risks of brain herniation and maximize neurological recovery. Current guidelines recommend urgent surgical evacuation for patients with a GCS less than 9 or with clear evidence of worsening neurological function, including anisocoria and progressive motor deficits. As the cases illustrate, early intervention plays a pivotal role in improving outcomes, and this principle should guide clinical decision-making in the management of EDH.[2]

2. Case Series

Case 1

An 81-year-old female with a history of C2-T4 posterior instrumentation for right C6/7 facet dislocation presented with a scalp laceration after a fall. Initially, she exhibited no neurological deficits, but two hours later developed numbness and reduced motor function on her left side. A CT scan of the brain showed no intracranial pathology, but cervical spine CT revealed a minimally displaced C2 fracture with a loosened C2 screw. MRI of the cervical spine demonstrated an extensive epidural hematoma from the foramen magnum to T1, with cord edema at the C4-C6 levels and multi-level stenosis at C3-C6. Neurological examination revealed decreased strength in both upper limbs (MRC grade 3-4) and complete paralysis in the lower limbs (MRC grade 0). The patient underwent posterior cervical decompression within 12 hours of symptom onset, which included evacuation of the hematoma via a C3-C6 laminectomy. Despite no anticoagulant therapy, significant intraoperative bleeding required meticulous hemostasis.

The patient’s postoperative course was favorable, with early signs of neurological recovery, including improved motor function in the right upper limb (MRC grade 4) and partial movement in the right lower limb. At one month post-surgery, her neurological status showed further improvement with ambulation supported by walking aids. This case highlights the importance of early surgical intervention within 12 hours to evacuate the hematoma and decompress the spinal cord, which is critical for preventing long-term neurological deficits. Delayed intervention could have led to irreversible damage due to the prolonged compression of the spinal cord, as seen in other studies demonstrating the adverse effects of delayed EDH evacuation.

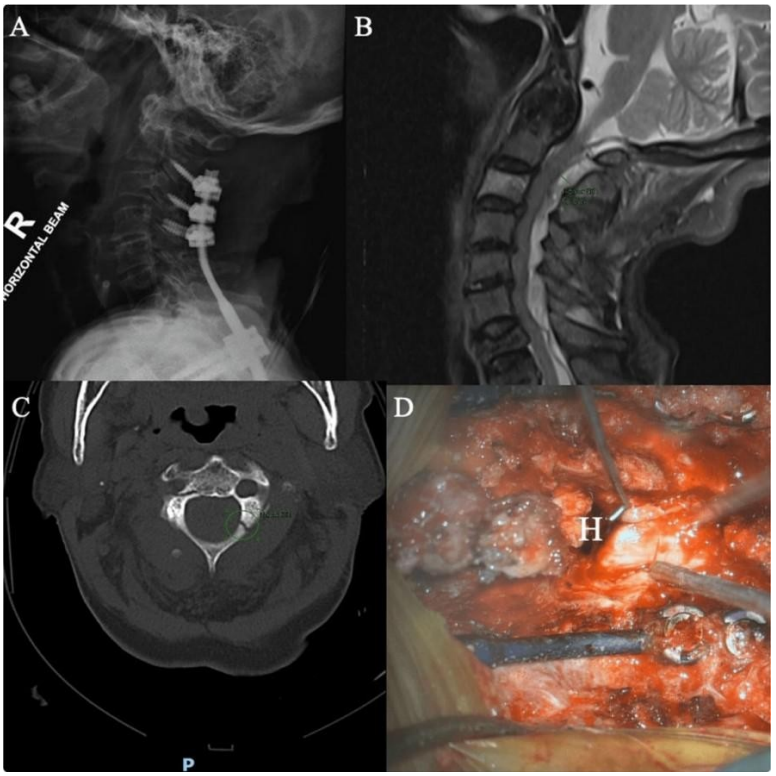

Figure 1. Case no. 1. (A) Lateral cervical X-ray: C2-T4 posterior instrumentation for right C6/7 facet dislocation, (B) Cervical CT: Minimally displaced C2 (atypical hangman) fracture with loosened left C2 screw, (C) MRI-CS: Extensive epidural hematoma from foramen magnum to T1, cord edema at C4-C6, and multi-level stenosis at C3-C6, (D) Intraoperative photo: Hematoma (labeled "H").

Case 2

A 73-year-old male presented to the Emergency Department following a fall from a stationary motorcycle, with neck pain and upper limb weakness. Physical examination revealed tenderness over the C5/C6 region and motor deficits in the bilateral C6-T1 segments (MRC grade 2). Initial imaging showed minimally displaced C5 and C6 vertebral fractures, with no intracranial pathology. MRI of the cervical spine revealed a large epidural hematoma extending from C1 to T2, with cord edema between C4 and C6. The patient was admitted with a cervical collar and closely monitored in the High Dependency Unit. Within 12 hours, the patient underwent posterior cervical decompression and instrumentation, with evacuation of the hematoma through a C6 laminectomy. Intraoperatively, an extensive organized epidural hematoma was observed from C5 to C7, requiring meticulous evacuation.

Postoperatively, the patient showed significant improvement in upper limb strength by postoperative day two (POD 2) and was transferred to the Rehabilitation Department by POD 5. By three weeks post-surgery, the patient demonstrated improved motor function, with MRC grades ranging from 3 to 4 in the bilateral C6-T1 segments. Follow-up radiographs at one and four months postoperatively confirmed stable instrumentation, and the patient continued to report neurological improvement. At four months, his neurological function had improved to MRC grade 5 in the right upper limb, grade 4 in the left C6-7 levels, and grade 3 in the left C7-T1 levels. This case emphasizes the critical importance of early surgical intervention within 12 hours to evacuate the epidural hematoma and prevent irreversible neurological damage, as delayed decompression can result in permanent deficits.

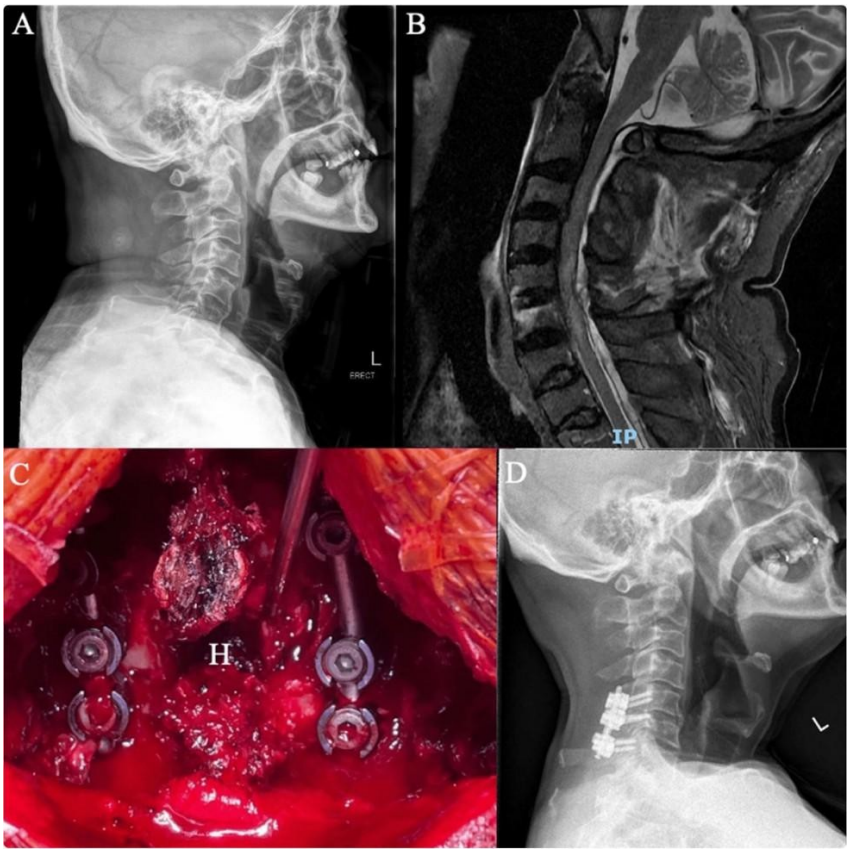

Figure 2. Case no. 2. (A) Lateral cervical X-ray: Minimally displaced vertebral body fractures at C5 and C6, (B) Cervical MRI (MRI-CS): Large epidural hematoma from C1 to T2 with cord edema at C4-C6, (C) Intraoperative photo: Hematoma (labeled "H"), (D) Postoperative lateral cervical X-ray: Stable implants.

3. Discussion

Epidural hematomas (EDH) result from the accumulation of blood between the dura mater and the skull, typically following trauma. The pathophysiology of EDH involves the rupture of meningeal arteries or veins, which leads to rapid blood accumulation within the epidural space, exerting pressure on the brain. As the hematoma expands, it causes an increase in intracranial pressure (ICP), which can compromise cerebral perfusion. Elevated ICP leads to decreased oxygen delivery to brain tissue, ultimately resulting in cerebral ischemia and, if untreated, irreversible brain damage. Furthermore, continued expansion of the hematoma can lead to midline shifts, which increase the risk of brain herniation, a life-threatening complication. In clinical practice, the decision to intervene surgically is critical to prevent further neurological deterioration, and it relies heavily on the accurate assessment of ICP and the rate of hematoma progression.[3]

The concept of the "golden hour" in traumatic brain injury (TBI) emphasizes the importance of timely surgical intervention for EDH. This term reflects the crucial window during which surgical decompression can significantly improve outcomes by preventing irreversible damage to the brain. Studies have demonstrated that patients who receive surgical intervention within the first few hours of symptom onset show markedly better neurological recovery than those who experience delays in surgery. Prompt decompression not only prevents herniation but also reduces the extent of secondary brain injury associated with elevated ICP. Thus, early recognition of symptoms, along with rapid imaging and decision-making, is paramount in improving patient prognosis.[4, 5]

Recent advances in neuroimaging have significantly improved the detection of EDH. High-resolution CT and MRI scans allow for accurate localization and assessment of hematoma size, both of which are critical in determining the appropriate timing for surgical intervention. Larger hematomas or those causing significant mass effect typically require more urgent decompression, whereas smaller or less symptomatic hematomas may be managed conservatively with close monitoring. However, a challenge remains in determining the optimal threshold for intervention, as rapid changes in patient condition can occur, particularly in the early hours following trauma. Moreover, the decision-making process often involves balancing the risks of surgery against the potential for deterioration if intervention is delayed.[6, 7]

One of the main clinical challenges in managing EDH is the lack of timely access to operative facilities, particularly in rural or resource-limited settings. The delay in receiving timely surgical care can significantly impact outcomes, with studies indicating that a delay of even a few hours can result in poorer functional recovery. In some cases, patients may be transferred from remote hospitals, which can further prolong the time to surgery. In these situations, the management strategy must prioritize stabilization and timely transfer to centers with appropriate surgical expertise. Advanced training in recognizing signs of EDH, alongside protocols for emergency transfer, can improve outcomes in these high-risk cases.[1, 8]

In addition to the time-dependent nature of EDH management, patient comorbidities also play a role in surgical decision-making. Older patients, such as those seen in the case studies, may have more fragile cerebral vasculature, which increases the likelihood of hematoma formation and complicates surgical procedures. Age-related changes in brain structure, including brain atrophy, can lead to greater space for hematoma expansion and exacerbate ICP effects. These patients may also have other medical conditions that complicate anesthesia or recovery, adding complexity to the decision regarding the timing and method of intervention. Therefore, individualized care plans that take into account the patient's overall health, age, and risk factors are essential in determining the optimal surgical approach.[9]

The postoperative management of EDH patients is also critical to prevent complications and optimize recovery. Early neurological assessments post-surgery, including frequent checks for signs of increased ICP and herniation, help guide subsequent interventions. Monitoring strategies such as intracranial pressure (ICP) monitoring or neurological scoring systems, like the Glasgow Coma Scale (GCS), can provide important feedback on the patient’s recovery trajectory. Furthermore, multimodal anesthesia and analgesia are often employed to manage pain and minimize neurological disturbance during the recovery phase. A coordinated multidisciplinary approach, including neurocritical care, is essential for these patients to ensure the best possible outcome.[10]

In some cases, the complications of EDH may persist even after successful evacuation of the hematoma. Residual neurological deficits, although rare, can occur due to prolonged pressure on the brain or secondary ischemic damage. Rehabilitation strategies, including physical therapy, occupational therapy, and speech therapy, are often required to address motor and cognitive deficits. Furthermore, long-term follow-up is essential to monitor for any delayed complications such as hydrocephalus or the development of post-traumatic epilepsy. Comprehensive post-surgical care and rehabilitation are critical components of EDH management, particularly in older adults, to maximize functional recovery.[10, 11]

The prognostic factors influencing EDH outcomes include hematoma volume, timing of intervention, patient age, and the presence of pre-existing neurological deficits. Large hematomas, particularly those associated with significant midline shift, are associated with poorer outcomes, emphasizing the need for early intervention. As illustrated by the case studies, prompt surgical

intervention within the first few hours of symptom onset led to significant improvements in neurological function. Although early decompression is crucial, there remains a need for personalized treatment protocols that consider the unique clinical circumstances of each patient. This includes taking into account not only the timing of surgery but also the anatomical location of the hematoma and any associated spinal or cranial injuries.[12]

The management of EDH requires a balance between timely surgical intervention and the consideration of individual patient factors. The “golden hour” concept remains a key tenet in optimizing outcomes, but clinical judgment, advanced neuroimaging, and multi-disciplinary coordination are equally important. Challenges such as limited access to surgical care, particularly in resource-poor settings, must be addressed through improved infrastructure and training. Ongoing research into optimal timing for surgery and postoperative management will continue to inform evidence-based guidelines that can improve patient outcomes across diverse healthcare settings.[2,13]

4. Conclusion

Timely surgical intervention for epidural hematomas (EDH) is crucial to prevent brain herniation and irreversible neurological damage. The "golden hour" concept highlights the importance of early decompression, ideally within hours of symptom onset. Challenges such as delayed access to care must be managed, particularly in resource-limited settings. Ultimately, individualized treatment based on the patient's condition, comorbidities, and the hematoma’s size and location is essential for optimal outcomes.

References

[1] Maas AI, Stocchetti N, Bullock R. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. Lancet Neurol. 2017;16(12):987-1048.

[2] Yang C, Jalloh I, Montagne A, et al. Prospective randomized evaluation of decompressive ipsilateral craniectomy for traumatic acute epidural hematoma (PREDICT-AEDH): study protocol for a randomized controlled trial. Trials. 2021;22(1):421.

[3] Weigel R, Schilling L, Krauss JK. The pathophysiology of chronic subdural hematoma revisited: emphasis on aging processes as key factor. GeroScience. 2022;44(3):1353-1371.

[4] Shukla D, Patel T, Mistry K, et al. Performance of a new portable near-infrared spectroscopy device for detection of traumatic intracranial hematoma. Injury. 2023;54(5):1278-1286.

[5] Salam MA, Rumi AH, Rahman N, et al. Factors influencing the surgical outcomes of extradural haematoma. J Natl Inst Neurosci Bangladesh. 2021;7(1):65-68.

[6] Tsioris AJ, Lui YW. Neuroimaging update on traumatic brain injury. Dis Brain Head Neck Spine. 2024;87-112.

[7] Alshammary NS, Alahmari KS, et al. The role of imaging in the evaluation and management of traumatic brain injuries: a review article. Med J Cairo Univ. 2023;91(12):1685-1690.

[8] Peres CMA, Oliveira MT, Ribeiro AM. Endovascular management of acute epidural hematomas: clinical experience with 80 cases. J Neurosurg. 2018;128(4):1044-1050.

[9] Kerezoudis P, Cook C, Geng J, et al. Morbidity and mortality in elderly patients undergoing evacuation of acute traumatic subdural hematoma. Neurosurg Focus. 2020;49(4):E22.

[10] Marhold F, Pospisil J, Beranek M, et al. The importance of additional intracranial injuries in epidural hematomas: detailed clinical analysis, long-term outcome, and literature review in surgically managed epidural hematomas. Front Surg. 2023;10:1188861.

[11] Laaidi A, Ghanem H, Li L, et al. Contralateral epidural hematoma after decompressive surgery: case report and systematic literature review. Ann Med Surg. 2022;74:103233.
[12] Kulesza B, Sobolewski P, Zalewski J, et al. Factors with the strongest prognostic value associated with in-hospital mortality rate among patients operated for acute subdural and epidural hematoma. Eur J Trauma Emerg Surg. 2021;47(7):1517-1525.
[13] Ganjifard M, Espahbodi E, Tafakhori A. Epidural blood patch in subdural hematoma due to spontaneous intracranial hypotension: a case report and review. Arch Anesthesiol Crit Care. 2024;10(3):296-302.