Anesthetic Management of Acute Epidural Hematoma with Imminent Cerebral Herniation: A Clinical Case

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Abstract
Objective. To describe an anesthetic approach to emergency surgical treatment of acute epidural hematoma (EDH) accompanied by clinical signs of impending cerebral herniation.
Materials and Methods. A simulated clinical case was developed based on contemporary principles of severe traumatic brain injury management and published neurosurgical and anesthesiological recommendations. A 24-year-old patient with traumatic right temporoparietal EDH, progressive impairment of consciousness and anisocoria was considered. The main aspects of perioperative management included airway protection, prevention of hypoxemia and hypotension, controlled ventilation, management of intracranial hypertension and urgent surgical decompression.
Results. The patient was admitted after a high-energy head injury with progressive deterioration of consciousness. Glasgow Coma Scale score was 9/15. Computed tomography revealed a right temporoparietal epidural hematoma with significant mass effect and 7-mm midline shift. The right pupil was dilated and poorly reactive. Because of the combination of neurological deterioration, anisocoria and radiological signs of compression, emergency craniotomy was indicated. General anesthesia was performed with controlled tracheal intubation and continuous hemodynamic and respiratory monitoring. Particular attention was paid to maintaining adequate arterial pressure and oxygenation and avoiding excessive hypocapnia. Hyperosmolar therapy was used as a temporary measure for suspected intracranial hypertension. Surgical evacuation of the hematoma was performed without delay. Following decompression, pupillary asymmetry decreased and neurological status subsequently improved.
Conclusion. In acute EDH with signs of cerebral herniation, anesthetic management should be integrated into the emergency neurosurgical pathway. Prevention of hypotension, hypoxemia and uncontrolled changes in $PaCO_2$, together with rapid definitive evacuation of the hematoma, represents the principal strategy for limiting secondary brain injury.
Keywords: epidural hematoma; traumatic brain injury; cerebral herniation; neuroanesthesia; intracranial hypertension; craniotomy; neuroprotection.

Introduction

Acute epidural hematoma is a life-threatening complication of traumatic brain injury. Progressive accumulation of blood may cause intracranial hypertension, displacement of cerebral structures and transtentorial herniation. Clinical deterioration may occur rapidly, making timely diagnosis and surgical treatment critical. Russian neurosurgical literature emphasizes the association between traumatic intracranial hematomas, progressive brain compression and the development of hypertensive-dislocation syndrome.

Clinical Case and Methods

A simulated case of a 24-year-old man after a high-energy road traffic accident was analyzed. On admission, GCS was 9/15, with right-sided anisocoria and progressive impairment of consciousness. CT demonstrated a right temporoparietal EDH measuring approximately 34 cm^3, with compression of the lateral ventricle and 7-mm midline shift [1,2].
Emergency airway protection was performed because of impaired consciousness and the risk of aspiration. After preoxygenation, controlled tracheal intubation was performed with cervical spine precautions. General anesthesia was maintained with continuous monitoring of arterial pressure, oxygen saturation and end-tidal CO_2. Ventilation was adjusted to avoid both hypoxemia and excessive hypocapnia. Hyperosmolar therapy was administered as a temporary measure while the

neurosurgical team prepared for decompression. Emergency craniotomy with evacuation of the hematoma was subsequently performed.

The Brain Trauma Foundation recommends surgical evacuation of an acute EDH exceeding 30 cm^3 regardless of GCS, while patients with coma and anisocoria require evacuation as soon as possible.

Results

Following hematoma evacuation, the patient's pupillary asymmetry decreased and neurological status improved during subsequent intensive care. The case demonstrates that anesthetic management should focus not only on providing adequate surgical anesthesia but also on preventing secondary cerebral insults. Maintenance of systemic perfusion is particularly important because hypotension during induction may reduce cerebral perfusion in the presence of increased intracranial pressure.

Controlled ventilation is also essential. Excessive hyperventilation may reduce cerebral blood flow, whereas hypercapnia can aggravate intracranial hypertension. Therefore, ventilation should be individualized according to the patient's neurological and intracranial status [3,4].

Discussion

The main anesthetic challenge in emergency evacuation of EDH is maintaining physiological stability during a period of rapidly changing intracranial dynamics. Airway manipulation, induction of anesthesia and positive-pressure ventilation may influence cerebral perfusion and intracranial pressure. Consequently, preparation for possible hypotension and continuous respiratory monitoring are essential [5,6,7].

Russian clinical and scientific literature indicates that the severity of traumatic brain compression is associated with hematoma volume, rate of formation, midline displacement and the degree of neurological deterioration.Contemporary international recommendations similarly emphasize avoidance of secondary insults and urgent treatment of surgically significant intracranial hematomas.

Conclusion

Acute epidural hematoma with impending cerebral herniation requires simultaneous anesthetic and neurosurgical action. The principal anesthetic objectives are rapid airway protection, preservation of systemic and cerebral perfusion, adequate oxygenation, controlled ventilation and prevention of additional increases in intracranial pressure. Pharmacological measures may temporarily control intracranial hypertension but should not delay definitive surgical evacuation.

References

1. Bullock MR, Chesnut R, Ghajar J, Gordon D, Hartl R, Newell DW, et al. Surgical management of acute epidural hematomas. Neurosurgery. 2006;58(3 Suppl):S7-S15.

2. Carney N, Totten AM, O'Reilly C, Ullman JS, Hawryluk GWJ, Bell MJ, et al. Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. Neurosurgery. 2017;80(1):6-15. doi:10.1227/NEU.0000000000001432.

3. Hawryluk GWJ, Rubiano AM, Totten AM, Bell MJ, Citerio G, Adelson PD, et al. Guidelines for the management of severe traumatic brain injury: 2020 update of the decompressive craniectomy recommendations. Neurosurgery. 2020;87(3):427-434. doi:10.1093/neuros/nyaa278.

4. Cook AM, Morgan Jones G, Hawryluk GWJ, Mailloux P, McLaughlin D, Papangelou A, et al. Guidelines for the acute treatment of cerebral edema in neurocritical care patients. Neurocrit Care. 2020;32(3):647-666. doi:10.1007/s12028-020-00959-7.

5. Крылов ВВ, Талыпов АЭ, Петриков СС, Солодухин АА. Хирургическое лечение больных с тяжелой черепно-мозговой травмой. Нейрохирургия. 2007;(1):3-10.

6. Потапов АА, Крылов ВВ, Лихтерман ЛБ, Гаврилов АГ, Ерохин АП, Ошоров АВ, и др. Современные рекомендации по диагностике и лечению тяжелой черепно-мозговой травмы. Вопросы нейрохирургии имени Н.Н. Бурденко. 2006;(1):3-8.

7. Лихтерман ЛБ. Черепно-мозговая травма: диагностика и лечение. М.: ГЭОТАР-Медиа; 2010.