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Treatment Options for Intracranial Epidural Hematoma - An Integrative Review of the Past Three Decades

Opções de tratamento para hematoma epidural intracraniano - Uma revisão integrativa das últimas três décadas

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Abstract

Introduction Acute epidural intracranial hematoma (IEH) has been considered one of the most relevant neurosurgical emergencies in recent decades due to its high potential for morbidity and mortality. Early diagnosis followed by appropriate treatment results in a more favorable prognosis considering its rapid progression.

Objective To describe the various treatment modalities for IEH in the last three decades and their updates.

Methods Integrative literature review on therapeutic options in IEH treatment. The terms "Epidural hematoma," "Traumatic brain injury," and "treatment" were used in the Medline/PubMed, Google Scholar, and SciELO platforms, resulting in 90 articles.

Results Appropriate treatment for IEH depends directly on the Glasgow Coma Scale score obtained during admission, bleeding location, lesion size, presence of associated intracranial injuries, and the neurosurgeon's experience.

Conclusion Initial treatment for IEH is predominantly surgical, with conservative treatment indicated in selected cases. Both neurosurgeons and clinicians must identify characteristic signs and symptoms promptly to avoid treatment delay. Moreover, minimally invasive approaches have gained prominence in recent decades, associated with image-guided procedures, and when well-indicated, result in rapid recovery and lower morbidity.

Keywords

- acute intracranial epidural hematoma
- head trauma
- treatment
- craniotomy
- conservative treatment
- endovascular embolization

Resumo

Introdução O hematoma epidural intracraniano agudo (HEIA) tem sido considerado uma das emergências neurocirúrgicas de maior relevância das últimas décadas devido ao seu alto potencial de morbimortalidade. O diagnóstico precoce seguido de

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tratamento adequado resulta em prognóstico mais favorável, tendo em vista sua progressão galopante.

Objetivo Descrever as diversas modalidades de tratamento do HEIA nas últimas três décadas e suas atualizações.

Métodos Revisão integrativa de literatura sobre as opções terapêuticas no tratamento do HEIA. Foram utilizados os termos: "Hematoma epidural", "Traumatismo cranioencefálico" e "tratamento" nas plataformas Medline/PubMed, Google Scholar e SciELO, resultando em 90 artigos.

Resultados O tratamento adequado para o HEIA, depende diretamente do escore na escala de coma de Glasgow obtido durante a admissão, localização do sangramento, tamanho da lesão, presença de lesões intracranianas associadas e da experiência do neurocirurgião.

Conclusão O tratamento inicial para o HEIA é eminentemente cirúrgico. Sendo o tratamento conservador indicado em casos selecionados. É de suma importância que tanto neurocirurgiões quanto clínicos devam saber identificar os sinais e sintomas característicos para não retardar o tratamento. Além disso, a abordagem minimamente invasiva vem ganhando notoriedade nas últimas décadas, associada aos procedimentos guiados por imagem, e, quando bem indicadas, resultam numa rápida recuperação e menor morbidade.

Palavras-chave
- hematoma epidural agudo intracraniano
- traumatismo cranioencefálico
- tratamento
- craniotomia
- tratamento conservador
- embolização endovascular

Introduction

Intracranial epidural hematoma is defined as a collection of blood located between the dura mater and the cranial bones.[1,2] Acute intracranial epidural hematoma (IEH) accounts for 0.2% to 6% of all traumatic brain injuries (TBIs) and 9% to 12% of severe TBIs.[2–6] It predominantly affects the second and third decades of life.[3,7–9] In 70% to 90% of cases, it is due to motor vehicle accidents and accidental falls.[3,7,9,10] Its location is supratentorial in 90% and infratentorial in 10% of cases. Approximately 95% are unilateral and 5% are bilateral.[9,11]

The classic clinical picture of loss of consciousness after TBI followed by a lucid interval, accompanied by homolateral mydriasis to the hematoma and contralateral hemiparesis, with a decreased level of consciousness, occurs in only 20% of cases.[2] CT is the method of choice for initial diagnosis and treatment.[2] Treatment varies according to the size, location, evolution, neurological status of the patient, and findings on neuroimaging exams. The authors discuss the various means of invasive and non-invasive treatment of IEH.

Methods

Justification: IEH has been frequent in cases of traumatic brain injury (TBI). Various procedures have been performed with excellent results. **Objective:** To describe the various modalities of IEH treatment. **Methods:** Integrative literature review on therapeutic options in the treatment of IEH. The terms "Epidural hematoma," "Traumatic brain injury," and "treatment" were used in the Medline/PubMed, Google Scholar, and SciELO platforms, resulting in 90 articles selected based on inclusion and exclusion criteria, as well as their respective citation impact and content. **Inclusion criteria:** Articles written in Portuguese, English, and Spanish, published in the last three decades (1980-2023), absence of tangential discussion of the topic. **Exclusion criteria:** Articles published in languages other than Portuguese, English, and Spanish, publications outside the specified time frame, and tangential discussions of the topic. **Conclusion:** The treatment of IEH depends on a series of factors such as Glasgow Coma Scale score on admission, size, location, presence of associated intracranial lesions, findings of neuroimaging exams, and the experience of the neurosurgical team.

Discussion

IEH is a lesion that requires neurosurgical intervention in most cases. When it reaches a certain volume, it can cause elevated intracranial pressure (ICP) and lead the patient to a state of coma or cerebral herniation, and in some cases, death. Craniotomy has been the most indicated procedure for cerebral decompression.[1] The treatment of IEH ranges from conservative treatment to endovascular therapy, depending on the clinical picture and findings in neuroimaging exams. The main treatment options for IEH include conservative management, immediate surgery, exploratory craniotomy, conventional surgery, decompressive craniectomy, arterial embolization, ultrasound or computed tomography (CT) guided aspiration, and endoscopic drainage.[2,12–22]

Conservative Treatment

Several factors are reported to influence the strategic approach to IEH treatment. Selection criteria for conservative versus surgical treatment remain controversial.[12,23] The decision for conservative treatment and the timing for delayed intervention can be made on an individual basis

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and depend on parameters such as patient age, size and location of the hematoma, neurological status of the patient upon admission, and case evolution.[2,24] Shahid et al.[25] observed that young patients who underwent early surgery with no or minimal associated brain injury recovered better than those who underwent surgery late.

Conservative treatment is indicated in patients with a preserved level of consciousness, without focal neurological deficit, absence of associated intracranial lesion, and CT showing IEH volume below <30 ml, thickness below 15 mm, and midline shift below 5 mm six hours or more after trauma, but with constant clinical observation and CT monitoring; in case of neurological decompensation, immediate surgery is indicated. Bullock et al.[13] demonstrated that a volume between 12-38 ml was suitable for conservative treatment, but Chen et al.[12] suggest that hematoma larger than 30 ml, thickness greater than 15 mm, and midline shift greater than 5 mm constitute a strong indication for surgical drainage. There is still disagreement regarding the management of IEH located in the posterior fossa; several authors indicate surgical treatment in all cases due to the potential for a considerable mass effect in a small space. Wong[26] reported that IEH located in the posterior fossa, with a volume smaller than 10 ml, can undergo conservative treatment. In cases with associated intracranial lesions, it indicates greater severity of trauma, and conservative treatment is contraindicated.[8,27,28] Samadi-Motlagh et al.[29] used tranexamic acid in selected IEH patients for conservative treatment and observed a decrease in hematoma volume expansion compared to the control group that did not use the medication, concluding that tranexamic acid plays an important role in bleeding control in IEH patients and improves their prognosis.

An important consideration should be made regarding the timing of repeat CT scans in cases of conservative treatment. Hematoma volume increases in 23% of cases, beginning eight hours after trauma and completing within 36 hours.[30–32] Spontaneous resolution rarely occurs in cases undergoing conservative treatment.[33–35]

Conventional Surgery

Surgical treatment is indicated based on neurological status and head CT findings (►**Table 1**):

Surgical treatment is performed through osteoplastic craniotomy above the site of the hematoma, with coagulation of the lacerated vessel always necessary. Dura mater suturing at the edges of the craniotomy and in the center of the bone flap to prevent its recurrence. In cases of bleeding from venous sinuses, control is achieved through tamponade using gelfoam or surgicel, and the patient's head is elevated in bed to prevent air embolism.[10,13,36,37] It is important to emphasize that drains should not be placed in postoperative cases of IEH, as they may lead to local infection and have not been effective in cases of IEH recurrence.

Table 1 Indications for urgent surgery in cases of intracranial epidural hematoma

1. Coma with anisocoria and CT demonstrating IEH necessitate urgent surgery.
2. Coma and worsening neurological status in IEH with a volume > 25 ml.
3. Volume of IEH > 30 ml, even in the absence of symptoms.
4. Volume of IEH > 25 ml, located in the posterior fossa or temporal region.
5. Midline shift > 4 mm, with worsening neurological status.
6. Increase in volume of the IEH.

Immediate Surgery and Exploratory Trepanation

In cases where a patient presents in the emergency room with unilateral pupillary dilation, decerebrate posture, and signs of elevated intracranial pressure, emergency action may involve making a small incision in the suspected area above the hematoma. A quick trephine hole is made, allowing for partial drainage of the hematoma to relieve intracranial hypertension, followed by craniotomy, definitive hematoma drainage, and coagulation of the injured vessel.[14,38–40] In the presence of associated intracranial lesions (subdural hematoma, brain contusion, intracerebral hematoma) seen on CT scan, if necessary, surgical drainage is performed. Intraoperative ultrasound may sometimes be useful to identify deep lesions. In cases of decompressive craniectomy (DC) where the bone flap cannot be immediately repositioned, it should be preserved in the freezer or the fatty layer of the abdominal wall for later repositioning. This occurs when there is cerebral edema or an existing lesion seen on CT observed during surgery, or in cases of refractory intracranial hypertension developed perioperatively. A new CT scan is indicated to determine the extent of hematoma drainage and to identify late-evolving hematomas.

Decompressive Craniectomy

Considerable controversy exists regarding the initial treatment of IEH, especially the optimal surgical treatment option, particularly in patients with cerebral herniation. The recommended treatment for IEH is osteoplastic craniotomy and hematoma drainage with replacement of the bone flap. Experiences with decompressive craniectomies (DC) in IEH have been sparsely reported in the literature.[41–43] Korde et al.[15] reported their experience in ten cases of IEH with admission Glasgow Coma Scale (GCS) scores below 5, who underwent DC initially, and concluded that these patients showed better outcomes.

Other authors[2,44,45] recommend DC as the first choice in cases of massive hematoma and low GCS, and it has been beneficial. In some cases, hematoma drainage with additional DC may effectively prevent and/or alleviate postoperative cerebral infarction; however, further investigation through randomized clinical trials is needed for confirmation. Korde et al.[15] suggest DC in patients with admission GCS scores below 5, with anisocoria for more than two hours from the time of the first neurological examination, or bilateral mydriasis at presentation, as they independently contribute to massive cerebral infarction and diffuse cerebral edema.

Predictive imaging factors for DC indication include hematoma volume above 100 ml or the presence of the swirl sign. Evidence of infarction in the middle cerebral artery or posterior cerebral artery territory also serves as an indicator for DC, as

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does midline structure deviation, indicating elevated intracranial pressure. The incidence of post-traumatic cerebral infarction secondary to IEH is 18.2%, even higher in patients with risk factors such as transtemporal location, preoperative hypovolemic shock for more than 30 minutes, bilateral mydriasis, and preoperative cerebral herniation.[13,46,47]

DC plays a crucial role in controlling elevated intracranial pressure and is recommended when feasible in severe cases of post-traumatic cerebral infarction secondary to IEH.[46–50] According to Vilcinis et al,[16] DC may effectively reduce intracranial pressure, but its effects on outcomes remain unknown. However, DC associated with IEH drainage in patients with profound coma appears to have inferior outcomes compared to osteoplastic craniotomy. Therefore, DC associated with initial IEH drainage may represent the best surgical option in well-selected cases, although more prospective studies are needed for conclusive evidence.

Inappropriately indicated DC as initial hematoma drainage may lead to inevitable complications, such as cerebral hemodynamic abnormalities, subsequent cerebral necrosis, and infarction, as well as the need for cranioplasty. The decision to drain the hematoma with or without DC, especially in patients with cerebral herniation, remains controversial.[46,51]

Arterial Embolization

Recent technological advancements have enabled endovascular treatment in a variety of cerebrovascular lesions, including IEH.[18,52–55] Middle meningeal artery embolization plays a crucial role as an alternative treatment, particularly in certain coexisting disease scenarios where conventional surgical treatment of IEH is precluded.[55,56] For other authors, endovascular treatment has proven useful in cases of small IEH, serving as an effective treatment option.[17,18,54,57]

Endovascular treatment of the middle meningeal artery was initially described in 2004 by Suzuki et al,[18] and subsequent studies have reinforced its indication.[17,18,53,58] Endovascular intervention is a method that can be effective in treating IEH without hematoma progression compared to traditional craniotomy.[59,60] According to Madison et al,[59] treatment decisions depend on the severity of the patient's injury and their neurological conditions. Ye et al[61] reported that endovascular intervention yields good results in treating IEH complicated by oronasal hemorrhage due to skull base fracture. Other authors recommend endovascular intervention in the treatment of IEH or its progression.[18,62] Peres et al[17] treated 80 patients with IEH, primarily in temporal locations, with excellent results. Suzuki et al[18] used endovascular embolization in nine patients during the acute phase of IEH and achieved excellent outcomes. The potential role of endovascular embolization in the treatment of IEH in carefully selected patients has been beneficial.

Ultrasound and/or CT-Guided Aspiration

In cases of neonates, needle aspiration guided by transcranial ultrasound can be performed with excellent results.[63,64] Spontaneous resolution without the need for neurosurgical intervention may also occur, but in cases of voluminous IEH with mass effect, surgical treatment is indicated to prevent neurological deterioration and IEH ossification.[65]

Zhao et al[19] used traumatic IEH drainage in 33 selected patients, with puncture guided by CT and instillation of urokinase during drainage, concluding that this procedure is safe, simple, rapid, and accurate, as reported by other authors as well.[1,14,66]

In cases associated with cephalohematoma, aspiration can be performed due to the common finding of communication between these hematomas.[67–71] It has been described that between 61% to 70% of IEH in young children coexist with cephalohematoma, and half of these have communication between them.[68] Smets and Vanhanwaert[72] suggest that in the absence of neurological signs and symptoms, aspiration of the cephalohematoma to drain the communicating IEH in newborns can avoid a more aggressive surgical intervention.

Endoscopic Drainage and Minimally Invasive Surgery

Endoscopic treatment for IEH drainage has been rare. This procedure has been performed in cases of acute spinal epidural hematoma and subdural and intraparenchymal hematomas.[22,46,73] Oshima et al[55] performed a combined approach (endoscopy and embolization of the middle meningeal artery), under local anesthesia for IEH drainage, in an elderly patient with poor clinical conditions, with excellent results.

Minimally Invasive Surgery (MIS) has been increasingly performed in patients with intracranial hematoma. It has the advantage of better-preserving brain tissue compared to more invasive procedures. According to Huang et al,[74] MIS is suitable for uncomplicated IEH, while for IEH involving the temporal base or major venous sinuses, craniotomy is the preferred initial choice. Wang et al[46] reported good results in 59 cases of IEH treated with aspiration and drainage through MIS, using urokinase in eight cases with excellent results.

Tseng et al[21] concluded in their study that MIS assisted with an endoscope in traumatic hemorrhage are efficient and effective in carefully selected cases. According to Tseng et al,[21] its advantages include early decompression, reduced surgical time, less blood loss, small incisions, early recovery, short hospital stays, and lower operational costs. Lu et al[75] performed aspiration and drainage through MIS, being effective in treating 58 patients with IEH involving the transverse sinus. Other authors performed trepanation followed by urokinase instillation and concluded it to be an efficient, easily performed technique effective in IEH treatment in selected cases.[14,76,77] With the evolution of new devices and techniques, it will be a procedure to be successfully performed in experienced hands in the future.[55]

Prognosis

IEH is an important cause of morbidity and mortality in patients with TBI.[4] Factors that significantly influence prognosis include age, low GCS score on admission, presence of associated intradural injury, time elapsed between trauma and symptom onset, hematoma size, and location.[3,49,78,79] Mortality from IEH varies from 0% to 21%.[12,80–84] Stephanov[85]

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demonstrated that pre-CT era mortality ranged from 16% to 52%, while post-CT era mortality ranged from 8% to 14%. This author concluded that rapid patient transport to a neurosurgical referral center was the most important factor in reducing mortality. Jones et al[86] reported a decrease in mortality from 29% to 8% over the last 35 years. Other authors have shown that the absence of an early diagnosis, anisocoria, preoperative GCS score, time between injury and surgery, and presence of associated intradural injuries contribute to high morbidity and mortality.[87–90]

Conclusion

The treatment of IEH is considered one of the most rewarding neurosurgical interventions for the neurosurgeon because when treated early and appropriately, the patient transitions from a severe neurological state to a normal one. Therefore, it is of utmost importance that both neurosurgeons and clinicians be able to identify the characteristic signs and symptoms to avoid treatment delay. Furthermore, it is concluded that treatment is invariably surgical in many cases. Additionally, it is worth noting that minimally invasive approaches have gained prominence in recent decades, associated with image-guided procedures, and when well-indicated, result in rapid recovery and lower morbidity.

Conflict of Interest
The authors report no conflicts of interest.

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