THIEME OPEN ACCESS

Therapy Options in the Management of Brain Abscess. Literature Review

Opções de terapia no tratamento de abscesso cerebral. Revisão da literatura

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Arq Bras Neurocir 2024;43(4):e337-e342.

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Abstract **Introduction** Despite the advancements in modern neurosurgical techniques, new antibiotics, neuroimaging technologies, anesthesia practices, and microbial isolation methods, cerebral abscess remains a potentially fatal infection of the central nervous system. Its treatment remains controversial to this day. The combination of clinical and surgical interventions has been widely accepted, yielding satisfactory outcomes. Methods The literature review process primarily relied on data obtained from the Pubmed database, Bireme (Lilacs, Medline, Scielo, Medicaribe, Cochrane). Key search terms included: central nervous system infection, cerebral abscess, and treatment. After a thorough selection analysis, 103 articles covering the period from 1980 to 2023 were included in this work. Results The ideal treatment is surgical; however, clinical treatment has been employed in selected cases. Simple aspiration, stereotactic-guided aspiration, and endoscopy have been performed with efficient results. The outcomes of clinical or surgical treatment depend on factors such as the patient's age, neurological status, microbial isolation, primary cause of the abscess, number of infectious foci, location, and stage of abscess development. Corticosteroids have been recommended for cases of vasogenic cerebral edema, while anticonvulsants are indicated for supratentorial **Keywords** abscesses. **Conclusion** The combination of aspiration or excision, tailored to the specific cause, brain abscess treatment number, location, and developmental stage, and intravenous antibiotics has consisoutcome tently yielded satisfactory results. Resumo Introdução Apesar do advento de modernas técnicas neurocirúrgicas, novos antibióticos, das tecnologias em neuroimagens, avanços no campo da anestesia, novas técnicas de isolamento de microorganismos, o abscesso cerebral permanece como uma infecção potencialmente fatal do sistema nervoso central. Seu tratamento é ainda

received December 13, 2023 accepted October 18, 2024 DOI https://doi.org/ 10.1055/s-0044-1795134. ISSN 0103-5355.

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Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

hoje controverso. A combinação do tratamento clínico e cirúrgico tem sido largamente aceita e com resultados satisfatórios.

Métodos O processo de revisão da literatura baseou-se principalmente em dados obtidos da Pubmed database, Bireme (Lilacs, Medline, Scielo, Medicaribe, Cochrane). Para as buscas foram usadas as palavras-chave: infecção do sistema nervoso central, abscesso cerebral, tratamento. Ao final da análise de seleção, obtiveram-se um total de 103 artigos que compuseram essa obra, com um recorte temporal de 1980 a 2023. Resultados O tratamento ideal é cirúrgico, porém, o tratamento clínico é realizado em casos selecionados. A aspiração simples, aspiração guiada por estereotaxia e endoscopia são realizadas com resultados eficientes. Os resultados do tratamento clínico ou cirúrgico, vão depender da idade, estado neurológico do paciente, isolamento do microorganismo, causa primária do abscesso, número de focos infecciosos, localização e fase de evolução do abscesso. Corticosteróides é indicado em casos de edema cerebral vasogênico. Anticonvulsivante nos casos de abscesso supratentorial. Conclusão A combinação de aspiração ou excisão conforme sua causa, número, localização e fase de evolução, associado com antibióticos por via venosa tem apresentado resultados satisfatórios.

Palavras-chave

- ► abscesso cerebral
- ► tratamento
- prognóstico

Introduction

A cerebral abscess (CA) is a collection of pus located within its respective site.^{1–5} CA typically presents with focal neurological deficit, seizures, or symptoms of increased intracranial pressure, and less commonly as a focal or systemic infection.^{6,7} The main causes and risk factors for the development of CA include meningitis, sinusitis, otitis, dental infection, open cranioencephalic trauma, cyanotic congenital heart disease, and previous craniotomy.^{8,9}

Neuroimaging studies are employed to determine the location, extent, characteristics of lesions, and course of action.^{10,11} Depending on the radiological pattern and stage of lesion development, a differential diagnosis should be considered, ranging from infection to tumor.¹² The combination of clinical treatment (oral, intravenous, intrathecal) and surgical intervention (drainage, aspiration, excision, stereotactic aspiration) is the standard for the curative resolution of CA.^{2,13–24} Clinical treatment has been used in cases of cerebritis-phase CA, multiple abscesses, or those located in eloquent areas.^{8,9,25} Various surgical procedures have been employed, such as simple aspiration, stereotactic aspiration, ultrasound-guided aspiration, neuronavigation-guided aspiration, or neuroendoscopy,^{12,26,27} and primary excision.^{22,26,28–33}

Despite advances in medicine through neuroimaging, microbial isolation, antibiotic therapy, and modern neurosurgical techniques (stereotaxy, neuronavigation), the morbidity and mortality rates remain high, particularly in developing countries.³⁴

The authors provide a review of CA treatment options and discuss their advantages and disadvantages.

Methods

This is a literature review conducted through searches on the following databases: Pubmed database, Bireme (Lilacs, Medline, Scielo, Medicaribe, Cochrane). The descriptors used were: Central Nervous System Infection, Cerebral Abscess, and Treatment. Articles were selected with a time frame from 1980 to 2023, resulting in a total of 103 articles that met the inclusion criteria based on their citations, respective impacts, and content relevant to the theme.

Pharmacological Treatment

Heineman et al.³⁵ reported the first successful case of clinical treatment for CA. Pharmacological treatment of CA has been indicated in cases of a single abscess < 1.5 cm, cerebritis phase, multiple abscesses measuring < 1.5 cm in diameter, located in eloquent areas, presence of concomitant infection (meningitis, ependymitis), and patients in the terminal phase.^{8,9,14,19,24,25,36–46}

Literature reports the effectiveness of clinical treatment in cases where the causative agent is known through blood culture, cerebrospinal fluid, or drainage from otitis or sinusitis.^{10,19,47} According to Armornpojnimman et al.,³⁸ the success rate for pharmacological treatment is high when initiated during the early cerebritis phase, with lesions measuring <1.5 cm in diameter, in patients with an evolution time of <2 weeks. Lu et al¹⁰ recommend clinical treatment when the diagnosis is uncertain or unconfirmed. According to Xiao et al,⁸ clinical treatment is not effective in patients with risk factors, poor level of consciousness, or immunodeficiency.

It is recommended to initiate empirical antibiotic therapy while samples are being analyzed for microbiological study.^{19,21,36,37,48,49} Broad-spectrum empirical antibiotic therapy should be maintained for 6 to 8 weeks, and modified according to the microbiological test results for possible effective therapy. Treatment duration of less than 6–8 weeks is associated with an increased risk of recurrence.⁵⁰ When the microorganism is unknown, the empirical antimicrobial therapy used is third-generation cephalosporin (cefotaxime, ceftriaxone) and metronidazole in the treatment of AC originating from otitis, mastoiditis, or sinusitis, showing good results.^{14,20,51} In cases secondary to open cranial trauma or post-craniotomy, a combination of third-generation cephalosporin with vancomycin or oxacillin is recommended. There is no consensus on the duration of antimicrobial therapy, with most authors recommending intravenous therapy for 6 to 8 weeks.^{10,44,52-56} Patients undergoing clinical treatment should be monitored clinically, laboratorially, and radiologically⁵⁵; if there is no clinical and/or radiological improvement, immediate surgical treat-

The effectiveness of pharmacological treatment can be observed through clinical improvement^{3,36} and laboratory tests such as PCR; when elevated, it indicates that pharma-cological treatment is ineffective.^{19,57,58}

The use of corticosteroids in CA is controversial.^{19,20,59} It has been indicated in cases of CA with local vasogenic edema, causing increased intracranial pressure and significantly increasing morbidity and mortality.^{8,24,44} It has been recommended in the perioperative period to reduce intracranial pressure and prevent internal brain herniation.^{10,20,21,40,47,59,60} Prolonged use of corticosteroids can decrease antibiotic penetration into the abscess and reduce abscess capsule formation, especially in the cerebritis phase.^{8,24,44,61-63}

Seizure is one of the main complications of CA, occurring at the onset of the disease or even after its treatment.⁶⁴ Anticonvulsant prophylaxis has been recommended.^{10,20,44} The most commonly used anticonvulsant is phenytoin, and for an extended period.

Surgical Treatment

ment should be instituted.⁸

The nature of CA, anatomical location, number of abscesses, size, stage of the lesion, age, and neurological status of the patient all influence the strategy for its treatment.¹⁰ In the historical evolution of CA treatment, in 1924, King⁶⁵ introduced the marsupialization technique. Dandy⁶⁶ introduced aspiration in 1926. Sargent⁶⁷ considered the excision of an encapsulated CA in 1928, but it was Vincent⁶⁸ who popularized complete excision and demonstrated its therapeutic value in 1936. The decision on the surgical technique should be made on an individual basis in each case, considering the size, location, overall condition of the patient, and the neurosurgeon's experience.^{5,58,69}

Simple Aspiration

There is a consensus that surgical treatment through puncture and aspiration is indicated for abscesses > 2 cm, located in non-eloquent areas, and with a significant mass effect, yielding excellent results.^{10,14,20,21,24,42,44,55,70-73} Large abscesses can be aspirated through a trephine hole, leading to an immediate reduction in mass effect and intracranial pressure, facilitating the collection of material for culture and antibiotic sensitivity testing.¹⁰ Simple aspiration has limitations in cases of multiloculated and recurrent abscesses.⁶³ A disadvantage of this procedure is the need to repeat it in 70% of cases and the risk of abscess rupture into the ventricular cavity or subarachnoid space, which can lead to complications such as meningitis and ventriculitis.¹³ Contraindications include the presence of coagulopathies.²⁰

Stereotactic-Guided Aspiration

Stereotactic-guided CT or MRI-guided aspiration and puncture in the treatment of CA have been considered the gold standard due to being a minimally invasive procedure and having a low rate of complications compared with excision.^{22,26,30,71,74,75} Advantages of this approach over other procedures include its use in cases of deeply located abscesses, eloquent areas, the brainstem, multiple abscesses, and when excision is deemed inappropriate.^{20,22,24,25,42,54,57,74,76–86} In stereotactic-guided aspiration, a biopsy of the abscess capsule can be performed.⁵⁴ According to Kondziola et al,⁷⁷ this technique is optimal for abscesses larger than 3 cm. Stapleton et al⁸⁷ suggest it as the method of choice for cases of superficial and large abscesses. Stereotactic surgery with neuronavigation allows for aspiration to be indicated without considering the phases of the abscess and enables the collection of material for laboratory study.10,18,36,88

Endoscopic Aspiration

The treatment of CA through endoscopy has been infrequently performed.^{27,89} In comparison with stereotactic-guided aspiration, neuroendoscopy offers some advantages such as direct visual control, the possibility of treating cases with multiseptated CA, addressing intraventricular purulent collections, cases of associated subdural empyema, and control of intraoperative bleeding.^{6,12,27,31,32,53} Endoscopic instruments can be flexible or rigid.^{6,12,27} Longatti et al⁶ used a flexible endoscope as it proved more effective in certain treatment scenarios, such as aspiration and inspection of the abscess in all spaces and directions. In cases where the capsule membrane is firm or elastic, its perforation may sometimes require the use of scissors or other instruments to facilitate the procedure.^{12,31}

Surgical Excision

Excision is generally recommended in cases of cerebellar abscess.^{19,20,44,54,90-93} Primary excision of the abscess and its capsule has also been performed in cases of multiloculated abscesses, cases due to more resistant pathogens that do not respond to multiple aspirations.^{20,39,54,62,63,94} Abscesses containing gas are resistant to antibiotics and are best treated through excision.⁹⁵ Post-traumatic abscesses containing foreign bodies or contaminated bone fragments are indicated for excision to prevent recurrence.^{19,44,71,91,96,97} Abscesses resulting from communicating fistulas, such as in cases of trauma or congenital dermal sinuses, require excision of the infected granulation tissue and closure of the fistula.¹⁰ Abscesses located in a lobe and contiguous to the primary source of infection show better results when subjected to excision along with the primary focus. Other authors indicate excision during the late stage of capsule formation or after unsuccessful aspiration.^{22,23} Primary excision is contraindicated in cases of cerebritis, deep abscesses, those located in eloquent areas, multiple abscesses, and patients at high surgical risk.^{10,13,98}

Complete excision of the CA is indicated in the following cases: 1. superficially located abscess in a non-eloquent area; 2. abscess suspected of fungal, Mycobacterium tuberculosis, Actinomyces spp, or Nocardia spp infection; 3. abscess resulting from congenital diseases or acquired fistula; 4. multiloculated abscesses; 5. abscess caused by a parameningeal septic focus; and 6. failure of previous treatment.^{10,58}

Intraventricular Abscesses

Cerebral abscesses located deep, multiloculated, and close to the ventricular wall increase the chances of intraventricular rupture in 10% of cases.⁹⁹ There is no efficient treatment of choice, and it presents a high mortality rate.^{100–102} Yang and Zhao¹⁰³ propose urgent craniotomy with abscess drainage. Other authors 39,101 suggest craniotomy followed by drainage of the abscess cavity, washing of the ventricular system, along intravenous and intrathecal antibiotic therapy for six weeks.

Conclusion

The synergistic approach of aspiration or excision, tailored to the specific cause, number, location, and developmental stage of cerebral abscess, coupled with intravenous antibiotic therapy, has demonstrated consistently satisfactory outcomes. Furthermore, the effective management of cerebral abscesses necessitates a comprehensive, multidisciplinary team, comprising neuroradiologists, neurologists, pediatric neurologists, infectious disease specialists, and neurosurgeons.

Conflicts of Interest The authors report no conflicts of interest.

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