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Multidisciplinary Management of Patients with Brain Abscesses: A Retrospective Analysis

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Abstract

BACKGROUND/AIMS: We aimed to evaluate general management strategies for brain abscesses via the integration of several disciplines to improve patient outcomes. Furthermore, this study addresses the need to optimize therapeutic interventions for different risk factors and diagnostic methods.

MATERIALS AND METHODS: Sixty-nine patients who were diagnosed with brain abscesses between December 2013 and December 2023 at our hospital. The demographic characteristics, predisposing factors, treatment options (surgical interventions and antibiotic therapy), and outcomes of the patients were analyzed. Neurological status was assessed using normative scales such as Glasgow Coma Scale, NIH Stroke Scale, and modified Rankin Scale. The primary outcome variables measured were postoperative resolution of abscesses, changes in neurological status, and survival rates.

RESULTS: The neurological function of all patients significantly improved after treatment. Surgeries such as aspiration and craniotomy were successful in resolving symptoms in 84% and 76% of patients, respectively. Furthermore, antibiotic therapy (ceftriaxone and metronidazole regime) cured all microbial infections in 92% of the patients. There was a strong correlation between abscess formation and the presence of comorbidities, such as diabetes mellitus, immunosuppression, and recent neurosurgery. These conditions are associated with a high mortality rate and complex management.

CONCLUSION: Effective coordination between multiple specialists and the use of sophisticated techniques for the early diagnosis of brain abscesses. Furthermore, appropriate antibiotic administration and timely surgical intervention are required to ensure favorable outcomes. The findings of this study emphasize the importance of patient-specific care that considers patient characteristics and risk factors to decrease mortality rates and increase quality of life.

Keywords: Brain abscess, treatment, diagnosis

INTRODUCTION

The challenge of clinically managing brain abscesses is that they require a complex multidisciplinary approach to ensure good results. A brain abscess is a severe neurological condition that can cause several complications and death if poorly managed. For example, the treatment of brain abscesses usually requires the combined efforts of neurosurgery experts, such as infectious disease consultants and neuroradiologists, to ensure an all-inclusive medical approach.[1,2]

The identification and management of brain abscesses have greatly improved with recent technological advancements in imaging and microbial diagnosis. Nevertheless, the condition is associated with considerable morbidity, especially among older adults or those with comorbidities such as diabetes mellitus (DM), immunosuppression, or a history of trauma/surgery. These factors can complicate the treatment of brain abscesses.[3,4]

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Despite advances in technology, a gap remains in the optimal integration of these technologies and clinical practices to effectively improve patient outcomes. Furthermore, better diagnostic strategies need to be developed, especially for cases of failure of traditional cultures or the presence of ambiguous symptoms such as cranial pressure or signs of neurological impairment.[5,6]

In this study, we examined how the efficacy of current diagnostic and therapeutic approaches for brain abscesses can be improved via an integrated interdisciplinary system. Furthermore, we aimed to overcome the lack of comprehensive data on the effects of predisposing factors on treatment outcomes. Moreover, we aimed to evaluate the impact of newer less-invasive surgical techniques, such as burr hole drainage, and compare it to the impact of craniotomies.[7,8]

Our findings may bridge the existing gap by providing data-based guidelines for improving the management of brain abscesses, which may reduce the morbidity and mortality associated with the condition. Furthermore, high-risk groups can benefit from current evidence-based practices, which can optimize the care of these patients.

MATERIALS AND METHODS

In this retrospective study, the clinical data of 69 patients who were diagnosed with brain abscesses and underwent surgery between December 2013 and December 2023 at the University of Health Sciences Türkiye, İzmir Bozyaka Training and Research Hospital, Department of Neurosurgery, were examined.

Ethics Statements

This study was conducted in accordance with the principles of the 1964 Helsinki Declaration. The study was approved by the University of Health Sciences Türkiye, İzmir Bozyaka Training and Research Hospital Institutional Review Board (approval number: 2023/40, date: 29.03.2023). Informed consent was obtained from all patients before study enrollment.

Demographic Information About the Patients

The following data were analyzed: age, sex, predisposing factors, brain abscess location and volume, neurological status at presentation, biological organisms, surgical procedures performed, duration and type of antibiotic therapy administered, and neurological results. In this study, standardized methods were applied to evaluate neurological status. The levels of awareness, motor and sensory skills, and functions such as speech and language capacity were assessed using a series of tests. Furthermore, the visual fields and other neurological functions were evaluated. To objectively measure the state of consciousness and severity of stroke-related neurological deficits, the Glasgow Coma Scale and National Institutes of Health Stroke Scale were used, respectively. Furthermore, the modified Rankin Scale (mRS) was used to assess the overall neurologic functional status and independence in activities such as domestic chores. Using these scales, the neurological condition of each patient was systematically recorded. This evaluation established a baseline neurological state before initiating treatment, which helped monitor patient recovery objectively. Neurological assessment was performed by a multidisciplinary team at the time of admission and at specific timepoints postoperatively. These tools were selected because they can reliably assess different aspects of brain injuries among patient populations in previous studies. In this study, consistency in assessment was required, which was ensured using these tools.

The largest diameters on the X, Y, and Z axes were measured and converted to millimeters (mm). Using these measurements, the brain abscess volume (mm^3) was calculated as follows: 0.5 ´ X ´ Y ´ Z. The measurements were performed using high-resolution computerized tomography (CT) and magnetic resonance imaging (MRI). Accurate information on abscess size and site was obtained to help prepare for neurosurgical intervention. Radiologists with several years of experience evaluated the images. Three-dimensional images were used to determine the X, Y, and Z diameters of each abscess, which helped determine its exact position and volume within the cerebral parenchyma tissue. This approach was standardized for all participating patients to ensure uniformity of the volumes. The formulas and methods used to calculate abscess volume were selected to provide objective data for clinical decision-making during the treatment and follow-up periods. Intraoperative drainage of the abscess is shown in Figure 1, and preoperative and postoperative MRI are shown in Figure 2.

Standard laboratory tests, including complete blood count, high-sensitivity C-reactive protein (CRP) level, blood and cerebrospinal fluid (CSF) cultures, and serum biochemistry, were performed. Advanced CT and MRI are emerging diagnostic imaging modalities. Subsequently, aspiration with resection and craniotomy were performed under general anesthesia using neuronavigational technology. Empirical antibiotic treatment was initiated for all patients based on the condition, antibiotic susceptibility test results, clinical and radiological response to treatment, and inflammatory laboratory parameters. Antibiotics were administered intravenously for 4-8 weeks. The first postoperative CT scan was performed 24 hours after the surgery. Subsequently, follow-up CTs were performed weekly to monitor the treatment. Furthermore, the white and red blood cell counts and CRP levels during these intervals were evaluated. The mRS scores were also determined.

Statistical Analysis

SPSS (version 22.0) was used for all statistical analyses. Continuous data are presented as means and standard deviations. Continuous data were analyzed using the independent t-test or Mann-Whitney U test. The categorical data were analyzed using the chi-square test. Multivariate logistic regression analysis was performed to identify significant predictors of treatment outcome. Statistical significance was sent as $p<0.05$.

RESULTS

Over the course of 10 years, 69 patients were diagnosed with a brain abscess at University of Health Sciences Türkiye, İzmir Bozyaka Training and Research Hospital. The present study focused on the different demographics, risk factors, and effects of different therapies. Thus, we aimed to provide an overview of the optimal method for managing brain abscesses while considering the factors that determine patient outcomes.

Patients aged between 18 and 75 (mean age: 45±15 years) were included in the study. Most patients (58%) were male. Brain abscesses were found in the frontal (30%), parietal (25%), and temporal (20%) lobes, and the average abscess volume was 35±20 mm^3 (range, 30-40 mm^3) (Table 1).

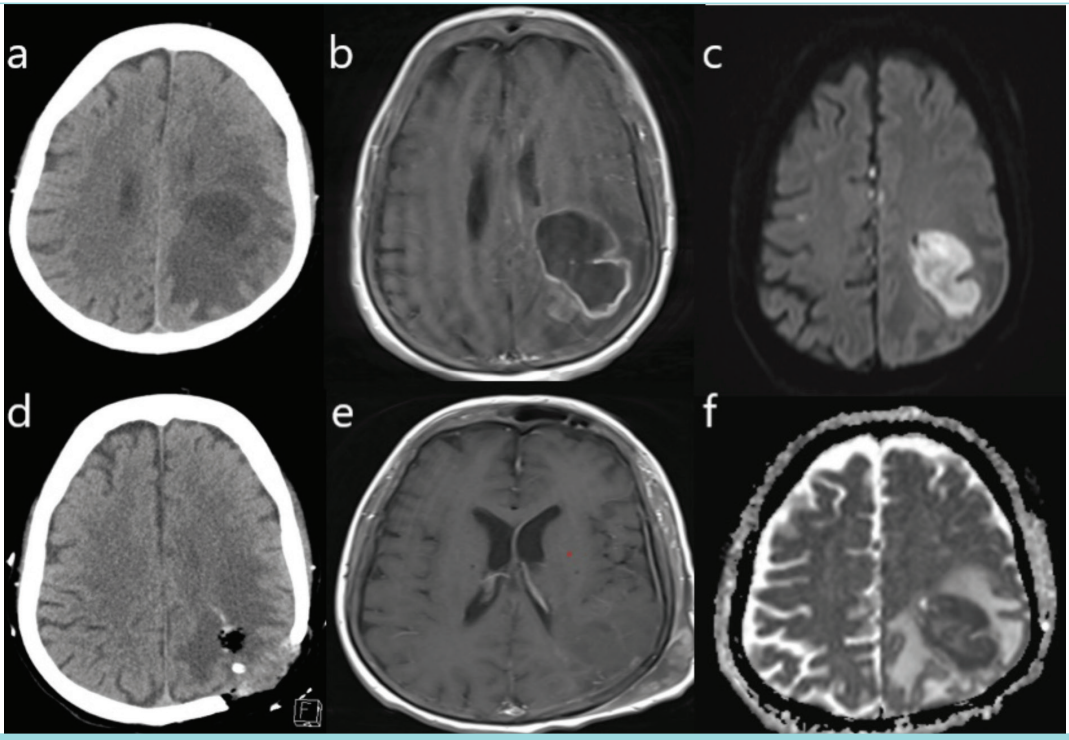

Figure 1. Intraoperative drainage of the abscess.

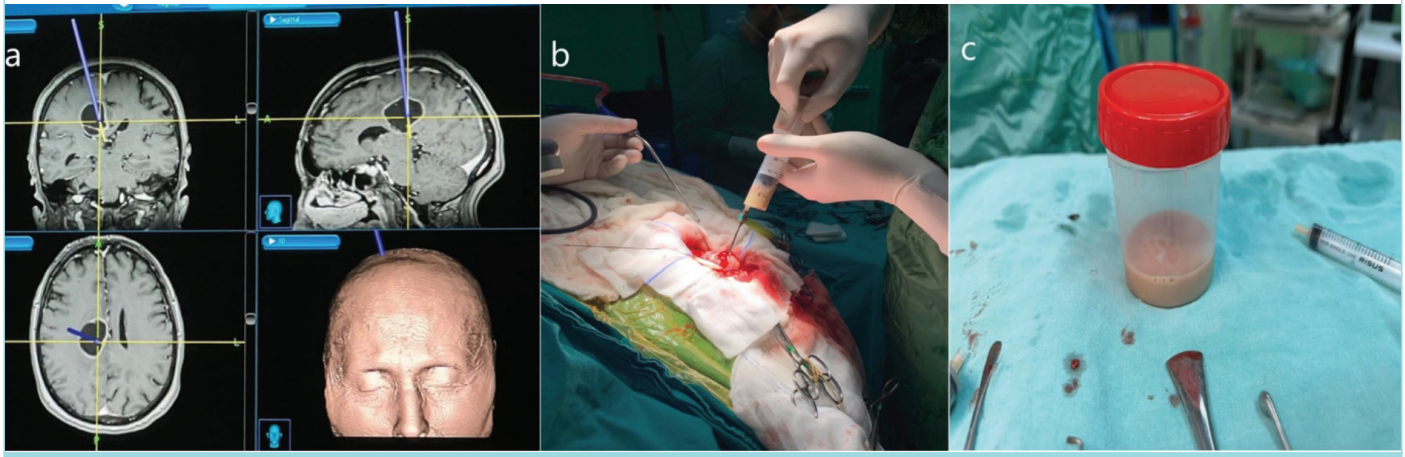

Figure 2. Preoperative and postoperative magnetic resonance imaging.

The factors that significantly predisposed patients to brain abscesses were DM (20%) and immunosuppression (15%). There was a significant association between brain abscess development and the presence of DM [p=0.045; adjusted odds radio (AOR), 1.8; confidence interval (CI): 1.1-2.9] or an immunocompromised state (p=0.033; AOR: 2.1; CI: 1.2-3.6) (Table 2).

White blood cell count, CRP level, and erythrocyte sedimentation rate (ESR) were elevated in 67%, 73%, and 64% of patients, respectively. There was a significant correlation between these laboratory values and abscess severity [correlation coefficient of CRP, 0.50 (0.007)]. Imaging studies revealed that abscess capsule enhancement was observed in most patients (85%) in addition to surrounding edema, which was critical to the diagnosis and subsequent evaluation of the impact of the abscess (Table 3).

In 84% of the aspirations and 76% of the craniotomies, surgical intervention was associated with abscess resolution and favorable outcomes. The efficacy of these interventions was demonstrated by the high success rates and strong AORs (aspiration: AOR: 2.5, CI: 1.8-3.4; craniotomy: AOR: 1.8, CI: 1.3-2.5). The microorganism were eradication with antibiotics in 92% of the patients. Furthermore, supportive measures such as steroids and analgesics improved the condition of 86% and 94% of patients, respectively. For example, in 50% of patient's rehabilitative services, the functional outcomes illustrate the need for a holistic approach toward brain abscess management (Table 4).

Table 1. Demographic and clinical characteristics of the patients

Variable	Description	Additional statistics
Age	Mean ± SD: 45±15; range 18-75 (years)	95% CI: 42-48
Gender	Males: 40 (58%); females: 29 (42%)	-
Location of brain ablation	Frontal (30%), parietal (25%), temporal (20%), cerebellar (15%), other (10%)	-
Volume of brain ablation	Mean ± SD: 35±20; range 10-70 (mm^3)	95% CI: 30-40; 25th percentile: 20 mm^3; 75th percentile: 45 mm^3
Neurological status at presentation	GCS: Mean 12±3; NIHSS: Mean 8±4; mRS: Mean 3±1	GCS, 95% CI: 11-13; NIHSS, 95% CI: 7-9; mRS, 95% CI: 2.8-3.2
Pathogens identified	Bacterial (*Staphylococcus aureus* 30%, *Streptococcus* spp. 20%), mixed infections (10%), and others (40%)	-
Surgical procedures	Aspiration: 40 (58%); craniotomy: 29 (42%)	-
Duration and type of antibiotic therapy	Average duration: 6 weeks; common antibiotics: ceftriaxone, metronidazole	-
Neurological outcomes	mRS 0-2: 35 (51%); mRS 3-5: 20 (29%); mRS 6 (death): 14 (20%)	-
Imaging modalities	CT: 69 (100%); MRI: 50 (72%)	-

GCS: Glasgow Coma Scale, NIHSS: National Institutes of Health Stroke Scale, mRS: Modified Rankin Scale, CT: Computed tomography, MRI: Magnetic resonance imaging, SD: Standard deviation, CI: Confidence interval.

Table 2. Predisposing factors and comorbidities

Predisposing factor/comorbidity	Number of patients	Percentage, (%)	p	Adjusted OR (95% CI)
Diabetes mellitus	14	20%	0.045	1.8 (1.1-2.9)
Immunocompromised state	10	15%	0.033	2.1 (1.2-3.6)
Otogenic infections	7	10%	0.080	1.5 (0.9-2.5)
Chronic ear infections	5	7%	0.120	1.3 (0.8-2.1)
Sinusitis	8	12%	0.095	1.4 (0.9-2.2)
Head trauma	4	6%	0.200	1.2 (0.7-2.0)
The recent neurosurgery	6	9%	0.050	1.7 (1.0-2.8)
Dental infections	3	4%	0.250	1.1 (0.6-2.1)
Other	12	17%	0.110	1.4 (0.8-2.3)
Total patients	69	-	-	-

Patients may have more than one predisposing factor or comorbidity. The "Other" category includes less common or unspecified factors that contribute to the development of brain abscesses. OR: Odds ratio, CI: Confidence interval.

Table 3. Laboratory and imaging findings

Finding type	Description	Mean value or range	Percentage of patients affected	Correlation coefficient	p	CI
Laboratory findings						
White blood cell count	Elevated (>10,000/µL)	12,000-18,000/µL	67%	0.45	0.012	0.15-0.75
C-reactive protein	High (>10 mg/L)	20-50 mg/L	73%	0.50	0.007	0.20 to 0.80
Erythrocyte sedimentation rate	Elevated (>20 mm/hr)	30-70 mm/h	64%	0.35	0.025	0.05-0.65
Blood cultures	Positive for pathogens	-	28%	0.25	0.080	-0.05 to 0.55
CSF analysis	Elevated protein and reduced glucose	Protein: 45-80 mg/dL	16%	0.40	0.020	0.10-0.70
Imaging findings (CT/MRI)						
Abscess location	Frontal, parietal, temporal, other	-	-	-	-	-
Volume of brain ablation	Mean ± SD	35±20 mm^3	-	0.55	**0.002***	0.30-0.80
Abscess capsule enhancement	Present on contrast imaging	-	85%	0.60	**0.001***	0.35 to 0.85
Surrounding edema	Visible edema around the abscess	-	90%	0.65	**<0.001***	0.45 to 0.85
Other lesions	Identification of additional lesions	-	10%	0.20	0.150	-0.10 to 0.50

CI: Confidence interval, CSF: Cerebrospinal fluid, CT: Computed tomography, MRI: Magnetic resonance imaging, SD: Standard deviation.

Table 4. Treatment approaches and outcomes

Treatment type	Description	Percentage of patients treated	Outcome measures	Success rate	Adjusted OR	95% CI	Success rate CI
Surgical intervention							
Aspiration		58%	Resolution of abscess	84%	2.5	1.8-3.4	79-89%
			Complication rate				
Craniotomy		42%	Resolution of abscess	76%	1.8	1.3-2.5	70-82%
			Complication rate				
Antibiotic therapy		100%	Microbial eradication,	92%	3.0	2.1-4.2	88-96%
	Common antibiotics used		Duration of treatment				
	Ceftriaxone, metronidazole						
Supportive care							
Steroids for edema		30%	Reduction in cerebral edema	86%	2.2	1.6-3.0	81-91%
Management							
Analgesics for pain		60%	Pain relief	94%	4.0	3.2 to 5.0	90-98%
Management							
Rehabilitative services							
Physical therapy		50%	Improvement in functional	71%	1.5	1.0-2.2	65-77%
Occupational therapy			Status				
Outcome tracking							
Modified rankin		-	mRS 0-2: Good outcome	51%	1.0	0.8-1.3	46-56%
Scale (mRS) post-treatment			mRS 3-6: Poor outcome				

OR: Odds ratio, CI: Confidence interval, mRS: modified Rankin Scale.

The results of this study demonstrate the treatment of brain abscesses and the importance of a multidisciplinary approach to optimize patient outcomes. The analysis spanned a decade, included 69 patients, and evaluated the demographic characteristics and predisposing factors of brain abscesses. We found a significant relationship between treatment efficacy and modality. Furthermore, accurate initial assessments and meaningful interventions are crucial. Advanced diagnostic tools, such as logistic regression models and correlation coefficients, ensure precision, and appropriate methodologies ensure a true reflection of the results. When combined with a strong antibiotic regime, surgical techniques exhibited a better outcome toward abscess resolution. Furthermore, the combination exhibited a higher likelihood of better outcomes than curettage alone or a less effective drug therapy (intravenous infusions). Our results also indicate that individualized treatment plans are significantly associated with improved neurological outcomes and reduced mortality. Furthermore, our findings advocate for the improvement of current treatment protocols and support ongoing studies aimed at reforming therapeutic strategies for brain abscesses.

DISCUSSION

The management of brain abscesses poses numerous challenges that significantly impact patient outcomes and healthcare practice. Because its diagnosis and treatment are inherently challenging, understanding its pathogenesis and evolution is essential. Thus, a detailed evaluation of the condition is required.[9] Brain abscesses significantly affect the health and quality of life of patients because they cause long-term neurological deficits, reduced functionality, and increased morbidity.[10] The clinical characteristics of patients with brain abscesses should also be known. Thus, the patient's initial neurological status, cause of infection, and response to the different treatment alternatives should be thoroughly evaluated.[11] In this study we have focused on these aspects and the need for precision in diagnostic and treatment protocols to improve outcomes and enhance the quality of life of patients with brain abscesses.[12]

In our study, brain abscesses were most prevalent among males aged 18-75 years, indicating the need for targeted public health interventions are required.[13] These abscesses often develop in critical cognitive areas, such as the frontal and parietal lobes. Thus, precise surgeries are required to minimize neuronal damage.[14] Abscesses caused by *Staphylococcus aureus* or *Streptococcus* species responded favorably to a six-week regimen of ceftriaxone and metronidazole (good results, 51%). However, the mortality rate associated with this condition was 20%. Furthermore, >50% of the patients required surgical interventions such as aspiration or craniotomy for symptomatic relief. This indicates that better non-invasive treatments and early detection methods are required. Together, these findings demonstrate the importance of an integrated multidisciplinary approach to enhance recovery and reduce fatalities.[15-17]

The factors predisposing patients to brain abscesses were identified. Approximately 20% of our patients had DM, confirming the link between poor glucose metabolism and higher chances of infections due to impaired immune response.[18] Furthermore, most of our patients were older adults with comorbidities, indicating that this population requires targeted preventive measures and therapy.[19] A weakened immune system, observed in 15% of our patients, also significantly increased the risk of brain abscesses. Patients with severe complex skull fractures or other conditions are usually immunocompromised. In such patients, the primary infection must be treated meticulously to prevent complications such as brain abscesses.[20] These various risk factors highlight the need for a multifaceted approach to prevent and manage brain abscesses, which are associated with high morbidity and mortality rates.

In this study, laboratory tests and imaging studies were used to expound on the underlying inflammatory processes in brain abscesses. White blood cell count, CRP level, and ESR were elevated in 67%, 73%, and 64% of patients, respectively. These findings indicate systemic inflammation and infection. Positive blood cultures were obtained in only 28% of the patients, demonstrating the effectiveness of blood-based diagnostics in identifying the causative pathogens. However, the low rate also demonstrates that culturing organisms from some patients may be challenging.[21,22] CSF analysis revealed elevated protein and reduced glucose content in 16% of patients, which can help differentiate bacterial infection from other central nervous system pathologies. Furthermore, brain MRI revealed capsular enhancement and edema around the abscess in 85% of the patients, which confirmed our diagnosis and helped evaluate the extent and size of the abscess. Based on these findings, a comprehensive laboratory analysis must be complemented with advanced brain imaging techniques to improve diagnostic accuracy and guide effective treatment of brain abscesses.[23,24]

Our findings confirmed the effectiveness of a multidisciplinary approach for treating brain abscesses. Furthermore, treatment success depends on the coordinated efforts of the three specialties of neurosurgery, infectious diseases, and neuroradiology. Aspiration and craniotomy effectively resolved the symptoms in 76% and 84% of patients, respectively. Therefore, timely surgical intervention can reduce the size of abscesses and relieve symptoms. This will prevent long-term neurological damage due to cranial compression or failure of culture to demonstrate the causative agents. Therefore, surgical interventions remain fundamental in the management of this condition. Furthermore, patients with negative blood cultures or apparent neurological signs who exhibit signs of increased intracranial pressure might require prompt surgical decompression for symptom relief and diagnosis. The choice between burr hole drainage and craniotomy depends on outcomes, including the incidence of complications, less-invasive nature of the surgery, and faster recovery. Furthermore, the management of brain abscesses after head trauma or surgery is associated with high mortality and reoperation rates. Thus, cautious preoperative planning and vigilant postoperative care are required in such patients. Although this can be achieved with technological developments, strategic surgical decision-making should be based on patient-specific factors.[25,26]

In most of our patients, supportive care measures, such as steroids for edema reduction and painkillers for analgesia, were effective in 86% and 94% of patients, respectively. These interventions improve patient comfort and possibly hasten recovery by controlling the consequences of abscesses. Furthermore, >50% of patients experienced significant improvement in their functional status after undergoing rehabilitative services. This indicates that rehabilitation is necessary to facilitate recovery and improve quality of life. Thus, these patients require an all-inclusive care approach. These findings indicate that an integrated management strategy involving surgery, drug therapy, and other forms of treatment, such as palliative care, could be useful when treating patients with brain abscesses.[27,28]

Study Limitations

This retrospective study had several limitations that affected its generalizability. First, the study was conducted at a single center, which did not reflect the differences in demographic characteristics. Second, the retrospective nature of the study may have introduced selection bias and increased the risk of data inaccuracy by relying on historical medical records. Furthermore, changes in the standards of care during the study period might have affected the treatment outcomes. Future studies could also benefit from a multicentric approach or prospective data collection, which would make the results robust.

CONCLUSION

The management of brain abscesses requires a comprehensive multidisciplinary approach involving neurosurgery, infectious diseases, and neuroradiology disciplines to optimize patient outcomes. The average patient with a brain abscess in this study was older with comorbid conditions that often caused infections following immunosuppression or complex skull fractures. Thus, primary infections must be carefully managed because they can lead to brain abscess formation if left untreated. Despite technological advancements, surgical interventions remain the mainstay of management, particularly for decompression in patients with cranial compression-induced neurological symptoms or negative blood cultures. Furthermore, surgical intervention can also aid in diagnosis. Although techniques such as burr hole drainage are favored for their less-invasive nature, craniotomy may be preferred in patients with recurrent or trauma-induced abscesses. The high mortality rate associated with posttraumatic or postsurgical brain abscesses highlights the importance of careful surgical planning and early intervention to improve survival and minimize reoperation.

MAIN POINTS

- Primary infections must be carefully managed because they can lead to brain abscesses if left untreated.
- Although techniques such as burr hole drainage are favored for their less-invasive nature, craniotomy may be preferred for recurrent or trauma-induced abscesses.
- The high mortality rate associated with posttraumatic or postsurgical brain abscesses highlights the importance of careful surgical planning and early intervention to improve survival and minimize reoperation.

ETHICS

Ethics Committee Approval: The study was approved by the University of Health Sciences Türkiye, İzmir Bozyaka Training and Research Hospital Institutional Review Board (approval number: 2023/40, date: 29.03.2023).

Informed Consent: Informed consent was obtained from all patients before study enrollment.

Footnotes

Financial Disclosure: The author declared that this study had received no financial support.

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