

Factors Influencing Outcome and Mortality of Brain Abscess in Mosul City

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ABSTRACT

Background: Brain abscess by definition is a crucial pus collection inside the brain, resulted from the infection by a variety of bacteria, fungi, and parasite. It can be single or multiple. The size, position, and number of lesions, as well as the organism's pathogenicity, host reactions, and the severity of cerebral edema, all influence the presentation.

Objective: To assess how well a brain abscess was managed and to evaluate the patients with favorable and unfavorable Glasgow outcome scale (GOS).

Patients and methods: From January 2014 to January 2021, the study was achieved and conducted in the Neurosurgical Department of Ibn-Sina Teaching Hospital on Mosul's left coast. The neurosurgery unit managed a case series investigation of 70 patients who had a brain abscess. Age, sex, duration of illness, initial neurosurgical status, and abscess features are among the clinical data.

A comparison was performed between patient with Favorable Glasgow outcome scale (GOS), moderate disability or those with good recovery and those with Unfavorable GOS, death or persist vegetate status outcome at discharge.

Results: The study involved 48 male and 22 female patients (male / female ratios 2.2:1). The series consist of 52 patients who experienced favorable outcome and 18 resulted from an unfavorable outcome. The mean of age for those patients was 20 years. The difference between males and females regarding favorable and unfavorable outcomes is insignificant. P-value was significant in cyanotic congenital heart diseases as cause of brain abscess were particularly prevalent among the children (adult VS children = 1:9). The most common site for single abscesses was the frontal lobe (25 patients), and majority of patients treated with burr hole drainage, which had the best results.

Conclusion: Although there were technological improvement of imaging and antibiotics treatment, the mortality of brain abscesses is still relatively high, especially among those with decreased level of consciousness on admission.

Keywords: Brain Abscess, Outcomes, Mortality.

عوامل خراج الدماغ المؤثرة على النتيجة والوفيات في مدينة الموصل

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الخلاصة

الخلفية: يعرف خراج الدماغ بأنه عبارة عن مجموعة صديد مهمة داخل الدماغ ، ناتجة عن الإصابة بمجموعة متنوعة من البكتيريا والفطريات والطفيليات. يمكن أن تكون مفردة أو متعددة. حجم وموقع وعدد الآفات ، فضلا عن إمرضية الكائن الحي ، ردود فعل المضيف ، وشدة الوذمة الدماغية ، كلها تؤثر على الأعراض.

الهدف: تقييم مدى جودة إدارة خراج الدماغ ، وتمت مقارنة وتقييم المرضى مع مقياس نتائج غلاسكو المواتية وغير المواتية (GOS).

المرضى وطرق العلاج : من يناير ٢٠١٤ إلى يناير ٢٠٢١ ، تم إجراء الدراسة في قسم جراحة الأعصاب بمستشفى ابن سينا التعليمي على الساحل الأيسر للموصل. أدارت وحدة جراحة المخ والأعصاب سلسلة حالات استقصائية شملت ٧٠ مريضاً يعانون من خراج في المخ. العمر والجنس ومدة المرض والحالة العصبية الأولية وميزات الخراج هي من بين البيانات السريرية. تم إجراء مقارنة بين المرضى الذين يعانون من مقياس نتائج غلاسكو المواتية (GOS) أو ذوي الإعاقة المعتدلة أو أولئك الذين يعانون من شفاء جيد وأولئك الذين يعانون من GOS غير المواتية أو الموت أو نتيجة حالة الخمول المستمرة عند الخروج.

النتائج : اشتملت الدراسة على ٤٨ مريضاً ذكوراً و ٢٢ أنثى (بنسب ذكور / إناث ٢.٢ : ١). تتكون العينة من ٥٢ مريضاً مارسوا نتيجة مواتية و ١٨ قدموا نتيجة غير مواتية. كان متوسط العمر لهؤلاء المرضى ٢٠ سنة. لفرق بين الذكور والإناث فيما يتعلق بالنتائج المواتية وغير المواتية ضئيل. كانت أمراض القلب الخلقية المزرقفة كسبب لخراج الدماغ منتشرة بشكل خاص بين الأطفال (البالغين مقابل الأطفال = ٩:١).

أن الموقع الأكثر شيوعاً للخراجات الفردية كان الفص الأمامي (٢٥ مريضاً) ، ومعظم المرضى الذين عولجوا عن طريق التصريف من خلال ثقب الجمجمة ويعطون أعلى نتيجة إيجابية.

الاستنتاجات : على الرغم من التحسن التكنولوجي في التصوير والعلاج بالمضادات الحيوية ، إلا أن معدل الوفيات من خراجات الدماغ لا يزال مرتفعاً نسبياً ، خاصة بين أولئك الذين يعانون من انخفاض في الوعي عند الدخول.

الكلمات المفتاحية : خراج دماغي ، نتائج ، وفيات.

INTRODUCTION

Brain abscess by definition is a crucial pus collection inside the brain, resulted from the infection by a variety of bacteria, fungi, and parasite. It can be single or multiple ¹.

Historically speaking, Macewen in 1876 made his first definition and localizing classification of brain abscess ². According to studies, brain abscesses account for roughly 8% of intracranial lumps in underdeveloped nations while in Western countries, it account for 1% to 2%, with four instances per million, it depends on geographic location and living standards within a given region. The incidence is higher in underdeveloped countries where the living conditions remain poor ³. *Contiguous infection* of the mastoid, middle ear, and paranasal sinuses are the most frequent causes of underlying infection in most clinical series ^{4,5}. *Hematogenous dissemination (Metastatic abscess)*, *Cyanotic congenital cardiac disease*, *Immunocompromised patient* and *previous craniotomy* are other source of brain abscess.

The size, position, and number of lesions, as well as the organism's pathogenicity, host reactions, and the severity of cerebral edema, all influence the presentation ⁶. There is no single symptom that is pathognomonic for a brain abscess ⁷. The most widespread symptoms of brain tissue destruction and edema are broad indicators of high intracranial pressure and local neurological impairment ⁸.

Brain abscess symptoms are difficult to distinguish from those of a tumor or other space-occupying lesion. The clinical features of an abscess, alternatively, tend to progress more quickly than those of a tumor ^{9,10}.

The symptoms become obvious within the early 2 weeks in 75 % of patients ¹¹. The headache is prominent in 70%-97% ¹² ; it is frequently constant progressive and refractory to therapy. Nausea and vomiting occur in 25%-50%, and more than 50% of patients have documented fever at the time of diagnosis usually of low grade ¹¹. Alteration of consciousness is present in up to two thirds of patients ^{11,12}. This ranges from mild confusion and drowsiness to obtundation and coma. Hemiparesis, Ataxia, and nystagmus are frequent symptoms of cerebellar abscesses ¹³.

The laboratory Findings include:

1. Blood analysis: this done by the peripheral leukocyte count which is frequently normal or only mildly elevated (less than 15.000/m) in up to 70% of patients. Moreover, the erythrocyte sedimentation rate (ESR) is elevated in up to 80% of patients in whom it is measured. The ESR averaged between 5 to 110 mm/h ^{14,15}.
2. Cerebrospinal fluid (CSF) analysis: CSF analysis yields vague results. Unless there is concurrent meningitis ^{16,17}.
3. Image Study: A computed tomography (CT) scan with contrast administration is a quick way to determine the size, number, and location of abscesses, classification, and staging in addition to the follow-up care ^{18,19}. Magnetic resonance imaging (MRI) provides imaging detail and resolution superior to CT scanning. It is more sensitive and accurate than CT in detecting early cerebritis.

Antibiotic effectiveness, concentration, duration, and specific organism response are all effective treatments²⁰. Surgical drainage or excision in combination with prolonged antibiotics (typically 4-8 weeks) is the preference option of treatment once an abscess has formed and is larger than 2.5 cm²¹. Corticosteroids are administered to manage cerebral edema and are contentious. Needle aspiration through the burr hole is the preferable method, which can be accomplished using a stereotactic operation aided by ultrasonography or CT scanning²². Patients treated solely with aspiration show excellent outcomes²³.

Craniotomy²⁴ is generally performed in patients with multi-loculated abscesses, cerebellar abscesses, traumatic abscesses, fungal abscesses²⁵.

MATERIALS AND METHODS

A case series study of 70 patients presenting with brain abscess was managed by neurosurgical unit in Ibn-Sina Hospital for the period from January 2014 to January 2021. All patients' data and records were obtained from the patient examination and follow up.

Clinical data include: Age, sex, medical history, duration of symptom, and the initial neurosurgical status. Potential prognostic factors were linked predisposing variables, laboratory data, and abscess features. CT-scan revealed the location of the abscess.

Antibiotic drug therapy given to those in early cerebritis stage and to those with size 2.5 cm and below with parenteral antibiotics (typically 4-8 weeks).we use [vancomycin plus ceftriaxone plus metronidazole]or [vancomycin plus meropenem]. Surgical drainage or excision is the preference option of treatment once an abscess has formed and is larger than 2.5 cm. Surgical excision indicated in failure of repeated burr holes, cerebellar abscesses, traumatic abscesses with foreign bodies, Fungal abscesses and gas containing abscesses. Medication also given as mention above with modification according to culture and sensitivity. Corticosteroids use to reduces edema in most cases.

An assessment was done between patients with

- 1.Favorable (GOS) Glasgow outcome scale: good recovery (5) or moderate disability (4) .
- 2.Unfavorable (GOS): severe disability(3), persist vegetate status (2), death (1) at discharge.

Level of consciousness was divided into (Glasgow coma scale) GCS >12 & ≤ 12 to make easy follow up and prognosis.

Univariate Chi square test analysis or Fisher's exact test was calculated to identify prognostic factors. The data were considered significant when the tailed p-value was ≤0.05.

We calculated the end-outcome incidence for every data set separately. After the admission period (6 weeks –6 months), the follow-up for 6 months begins. Only a few patients have long-standing follow-up information.

RESULTS

I- Age and Sex

The mean age of those patients is 19.7±14.0 years ranging from (3 month-60 year). There were 48 male and 22 female patients (male / female ratio 2.2:1).There is 21 children among the study sample Table 1 .

Table (1) Demonstrate initial presentation of the patients according to (age and sex)

Age and sex	Favorable	Unfavorable	Total	P-value*
	No. (%)	No. (%)	No. (%)	
Male	37 (71.0)	11 (61.0)	48 (68.5)	NS
Female	15 (29.0)	7 (39.0)	22 (31.5)	
Total	52	18	70	
Age/years mean±SD	19.2±14.3	18.4±14.3	19.7±14.0	0.838**

*Chi square test ** t-test NS= not significant

II-Sign and Symptom

Table (2) demonstrates the initial presentation of the patients according to duration with the signs and symptoms and revealed that, the mean duration of symptoms before being diagnosed by image studies was 14 ± 20 days. On admission, most patients had neurological manifestations such as focal neurological deficits and signs associated with increased intracranial pressure (IICP) (headache, nausea, vomiting, and papilledema). Fever was common and occurred in 40 patients 57.0%, 15(21.15%) of them had temperature of 38.5°c or higher. However, the classic triad of brain abscesses: fever, headache and focal neurological deficits are present in 24 patients (34.0%). The level of consciousness of the patients also shown in Table (2).

Table (2): Duration with Sign and Symptom of the patients.

	Favorable	Unfavorable	Total	P-value
	No. (%)	No. (%)	No. (%)	
Duration of symptom/day mean±SD	14 ±20	14.4 ± 20	12.0 ±19.0	NS
Sign Suggesting IICP	31 (59.5%)	10 (55.5%)	41 (58.5%)	NS
Focal neurological Deficit	28 (54.0%)	8 (44.5%)	36 (51.5%)	NS
Seizure	8 (15.0%)	2 (11.0%)	10 (14.5%)	NS
Fever	32 (61.5%)	8 (44.5%)	40 (57.0%)	NS
GCS>12	45 (86.5%)	9 (50.0%)	54 (77.0%)	0.001*
GCS≤ 12	7 (13.5%)	9 (50.0%)	16 (23.0%)	0.001*

IICP= increase intracranial pressure NS= not significant *=Fisher's exact test

Table (3) demonstrates the initial presentation of the patients according to the source of infection and illustrates that, hematogenous origin, contiguous origin, being diabetic, and immune compromised are statistically insignificant.

Table (3): The initial presentation of the patients according to the source of infection.

	Favorable	Unfavorable	Total	P-value
	No. (%)	No. (%)	No. (%)	
Hematogenous origin	18 (39.1%)	7 (29.1%)	25 (35.7%)	NS
Contiguous origin	13 (28.2%)	5 (7.1%)	18(25.7%)	NS
Diabetes mellitus	7 (10%)	4 (5.7%)	11 (15.7%)	NS
Immune compromised	8 (17.4%)	8 (11.4%)	16 (22.8%)	NS

*Chi square test NS= not significant

Table (4) demonstrates the hematogenous metastasis among the patients and shows that, the hematogenous metastasis associated with cyanotic heart diseases in 14.0% (1.5% in adults and 12.5% in children) with a very highly significant difference in between, 20% with lung infection and 1.5% with liver abscess.

Table (4): Hematogenous metastasis.

Hematogenous metastasis		No	%	p-value 0.001*
Cyanotic heart diseases	Adult	1	1.5%	
	Children	9	12.5%	
	Total	10	14.0%	
Lung infection		14	20%	
Liver abscess		1	1.5%	
Total		25	35.7%	

* Fisher's exact test.

Table (5) illustrates the counts and the percentages of contiguous infection and demonstrates that, the contiguous infection presents in 18 patients constituting 25.7%. Otitis media found in 8 patients representing 11.4%, chronic mastoiditis found in 6 patients representing 8.6% and only 4 patients have penetrating head injury and represents 5.7%.

Table (5): Contiguous infection.

Contiguous infection	No	%
Chronic otitis media	8	11.4%
Chronic mastoiditis	6	8.6%
Penetrating head injury	4	5.7%
Total	18	25.7%

Table (6) demonstrates the distribution of immune compromised patients and shows that, steroid drugs given to nephrotic syndrome and chronic asthma found in 10% of the patients, while hematological disorders, like chronic myeloid leukemia and aplastic anemia found in 12.8%.

Table (6): Immune compromised patients.

Immune compromised	No.	%
Steroid drug to nephrotic syndrome & chronic asthma	7	10%
Hematological disorder, chronic myeloid leukemia & aplastic anemia.	9	12.8%
Total	16	22.8%

Table (7) demonstrates the characteristics of brain abscess according to pathology and reveals that, the differences between favorable and unfavorable were statistically insignificant regarding specimen, Gram (+ve) cocci, Gram (-ve) cocci, anaerobes, and fungus.

Table (7): Characteristics of Brain abscess according to Pathology.

Abscess characteristic	Favorable	Unfavorable	Total	P-value
	No. (%)	No. (%)	No. (%)	
Sterile or no specimen	20 (38.5%)	9 (50.0%)	29 (41.5%)	NS
Gram (+ve) cocci	16 (30.5%)	2 (11.0%)	18 (25.5%)	NS
Gram (-ve) Cocci	7 (13.5%)	3 (16.5%)	10 (14.0%)	NS
Anaerobes	9 (7.5%)	3 (16.5%)	12 (17.0%)	NS
Fungus	0 (0.0%)	1 (5.5%)	1 (1.5%)	NS
Total	52	18	70	

NS= not significant

Table (8) shows the distribution of brain abscess characteristics according to the abscess location and depicts that, frontal site represents 34.5% of the favorable and 39.0% in unfavorable, the temporal accounts 17.5% in the favorable and 16.5% in unfavorable. The parietal constitutes 17.5% and 5.5%; the occipital 4.0% and 11.0%; posterior fossa 7.5% and 5.5%; the multiple abscesses 19.0% and 22.5% in favorable and unfavorable respectively in the same manner. The differences show insignificant p-value for the comparison between favorable and unfavorable.

Table (8): Brain abscess characteristics of patients according to abscess location.

Abscess characteristic	Favorable	Unfavorable	Total	P-value
	No. (%)	No. (%)	No. (%)	
Frontal	18 (34.5%)	7 (39.0%)	25 (35.5%)	NS
Temporal	9 (17.5%)	3 (16.5%)	12 (17.0%)	NS
Parietal	9 (17.5%)	1 (5.5%)	10 (14.0%)	NS
Occipital	2 (4.0%)	2 (11.0%)	4 (5.5%)	NS
Posterior Fossa	4 (7.5%)	1 (5.5%)	5 (7.0%)	NS
Multiple abscesses	10 (19.0%)	4 (22.5%)	14 (20.0%)	NS
Total	52	18	70	

NS= not significant

Table (9) demonstrates the distribution of brain abscess characteristics according to treatment and reveals that, among the favorable, the medical treatment, burr hole, and excision represent 13.5%, 67.5%, and 19.0% respectively, which are insignificantly, differ from that of unfavorable arrange as 16.5%, 72.5%, and 11.0% respectively.

Table (9): Brain abscess characteristics according to Treatment.

Abscess characteristic	Favorable	Unfavorable	Total	P-value
	No. (%)	No. (%)	No. (%)	
Medical treatment	7 (13.5%)	3 (16.5%)	10 (14.0%)	NS
Burr hole	35 (67.5%)	13 (72.5%)	48 (68.5%)	NS
Excision	10 (19.0%)	2 (11.0%)	12 (17.0%)	NS
Total	52	18	70	

NS= not significant

Table (10) shows the outcomes of the disease and demonstrates that, the full recovery occurs in 50.0% of the patients. The mild deficits represent 24.0%. Death occurs during the hospitalization of 17.0%, while severe disability accounts for only 9.0% of the patients.

Table (10): Outcomes of the disease.

	Outcome	No. (%)	Total No. (%)
Favorable outcome	Full recovery	35 (50.0%)	52 (74.0%)
	Mild deficits	17 (24.0%)	
Unfavorable outcome	Died during hospitalization	12 (17.0%)	18 (26.0%)
	Severe disability	6 (9.0%)	
Total		70 (100.0%)	70 (100.0%)

DISCUSSION

A male preponderance was noticed in this study with the fraction of 2.2 male: 1 female and this result was corresponding to the findings in other reported literatures²⁶⁻²⁸, but this difference was not seen in other studies^{29,30}.

The early manifestations frequently correlate with the location, size, evolution of the abscess, virulence of infecting pathogens, and underlying host situations³⁰. In the present study, the main symptoms are due to IICP (nausea, vomiting, and headache) in 41 (58.5%). Fever is also a common finding 40 (57.0%) as shown in table (2), which is similar to others studies³¹⁻³³.

The position and mass effect of the abscess determine focal neurological abnormalities; in our study, 36 (51.5%) in other investigations^{31,33,34}, more than 60%.

Hematogenous spread is common in the present study, and was found in 25 (35.7%) which is more than contiguous spread 18 (25.7%). Other studies show that, the contiguous source is the most frequent^{31,35-37}. Diabetes mellitus is 11(15.7%) and immune compromised 16 (22.8%) were lower than other studies,^{31,35} as illustrated in table (3).

Most Hematogenous source was with a shunt from right to left or cyanotic type of congenital cardiac disease as in other study³⁸. Also it's more in children, giving p-value 0.001 which is very highly significant as in table (4).

In patients with a shunt from right to left, decreased arterial oxygen saturation combined with increased blood viscosity owing to increased hemoglobin levels may cause focal ischemia in the brain that could serve as excellent nidi for infection³⁹.

Furthermore, because a shunt from right to left can skip the filter effect of pulmonary circulation, it has been suggested that correcting the shunt sooner rather than later may minimize the risk of abscess development in these patients³⁸.

The most common contiguous source is chronic otitis media 8 patients (11.4%), then chronic mastoiditis 6 patients (8.6%), then penetrating head injury 4(5.7%) patients as demonstrated in table (5), this incidence was low in comparable to other literatures^{32, 33, 40}.

In immune compromised patients abscesses are frequently caused by opportunistic organism (e.g., atypical bacteria, fungi, and parasites), which are not pathogenic in humans³⁹.

Although the frequency of sterile culture is elevated, as shown in table (7), careful culturing of abscess resources attained at the instance of surgery affords the best chance to make a microbiological diagnosis, despite the fact that the incidence of sterile culture is similar to findings of other studies^{37,41}.

However, an initial broad-spectrum antibiotic coverage for the most common organisms should be the first choice for all critically ill patients, even if the culture results are being awaited. Because the microorganisms that cause brain abscesses are often similar to that causing other septic foci, the initial antibiotic coverage could be based on the most likely ones at the hypothesized entry points. Complete excision is preferable to simple drainage in situations caused by these more resistant infections, such as fungus or *Nocardia* species³⁰.

Some studies have supported nonsurgical treatment for patients who are poor surgical candidates or have surgically inaccessible lesions since 1975⁴². The chief drawback of this strategy is the risk of toxicity associated with long-term empirical antibiotic therapy³¹. The surgical treatment should be attempted, except during the period of cerebritis, in order to reduce the mass effect and get abscess materials for identifying infecting bacteria and, therefore, enabling antibiotic selection⁴³. The following management policy has been recommended by Mamelak *et al*⁴⁴: aggressive surgical drainage of abscesses larger than 2.5cm in diameter, followed by antibiotics that given intravenously for 6 to 8 weeks and biweekly imaging studies for monitoring evidence of abscess re-expansion or failure to resolve despite antibiotics. With the availability of enhanced imaging studies, stereotactic procedures, and more broad-spectrum antibiotics, the role of aspiration has enlarged because of its simplicity. Stereotactic aspiration joints with antibiotic treatment can still be used in difficult-to-access places such as brain stems or eloquent areas in patients at high risk for surgery or with the multiple brain abscesses.⁴⁵

In the current study, 48 patients (68.5%) had aspiration via the burr hole and had a favorable outcome (67.5%), which was comparable to medical and excision (13.5%) and (19.0%), respectively, which was shown in table (9). Despite the fact that abscess excision is thought to reduce the clinical course⁴⁴, there has been no further improvement in the result^{33,35}.

With the advent of imaging technology and broad-spectrum antibiotics, our findings show that timely recognition of the diagnosis and effective infection control are critical to a favorable result. It is critical to identify the germs that are causing the abscess in order to manage it more effectively. When the clinical state allows, surgical techniques for acquiring culture materials should always be performed, even if the abscess is tiny (2.5cm), deeply seated, and/or numerous.

Although there were technological improvements of imaging and antibiotic management, the mortality of brain abscesses is still relatively high.

In the current work, the mortality was noticed in 17.0% as appears in table (10), which is similar to other studies (range, 17%-37%)^{33, 41, 46, 47}.

The most important factor that influences mortality is the neurological condition of the patient at the time of diagnosis^{34,35,37,48}. And this appear clearly in our study, patients with GCS more than 12 show high favorable outcome (68.5%), in comparison to those with low GCS less than 12 whose show low favorable outcome (13.5%), with significant p-value as in table (2).

Another finding is that death is mainly caused by systemic infection or terminal cancer rather than directly by the brain abscess itself, suggesting that, although the current therapeutic strategy for controlling these abscesses is highly effective, the decisive factor for patients' survival still depends on the host capability to combat offending pathogens⁴⁹.

CONCLUSIONS

1. Signs of IICP and disturbed consciousness are the main sign of brain abscess.
2. Poor state of consciousness on admission related to poor outcome and carries high mortality rate.
3. Patient who need burr hole treatment as indicated shows high favorable outcome in comparison to medical treatment and excision.
4. Mortality rate is high in this study 17.0%.

RECOMMENDATIONS

1. Early diagnosis of abscess in the brain of patient with chronic otitis media or congenital heart disease before a decline in level of consciousness.
2. Meticulous technique for bacteriological study for identification of offending pathogens.

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