International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Case Report

Spectrum of Intracranial Abscess: Options and Outcome

Vishwanath Sidram[1], Chandra Kumar P C[1], Bellara Raghavendra[2*], Mohammad Shafiuddin[3], Raghavendra F N[4]

[1]Assistant Professor, Dept of Neurosurgery, VIMS, Bellary, Karnataka
[2]Assistant Professor, Dept of Community Medicine, VIMS, Bellary.
[3]Assistant Professor, Dept of General Surgery, VIMS, Bellary.
[4]Assistant Professor, Dept of General Medicine, VIMS, Bellary

[*]Correspondence Email: bellararaghu@gmail.com

Received: 23/02//2012 *Revised: 8/03/2012* *Accepted: 17/03/2012*

ABSTRACT

Objectives: To study the clinical profile and predisposing factors of the patients with intracranial abscess and to study the current surgical options and outcome

Methodology: A case series study of ten patients with intracranial abscess was studied. Among the selected patients the socio-demographic profile, clinical profile and the surgical interventions undertaken and the outcome were noted. Appropriate descriptive statistics were used to analyse the findings and to draw the inferences.

Results: There were 6 males and 4 females. The mean age of presentation was 19.5 ±9.1 years (range being from 6 years to 32 years).The duration of illness at the time of admission was 32.7±13.5 days (range 15 days to 60 days). Typically patients presented with fever, vomiting, headache and seizures. The predisposing conditions found were CSOM 7 (70%) and paranasal sinusitis (30%). Computerized tomography confirmed the diagnosis and the most of the intracranial abscess were supratentorial 8(80%), solitary 9(90%) and intracerebral 6(60%) and the common location of the abscess was the temporal lobe of the cerebral hemisphere. All abscesses were large, more than 2 cm in diameter and were aspirated surgically. Secondary excision was performed in 5 patients and primary excision was done in 3 patients and 1 patient was treated conservatively. Complications were seen in 2 patients.

Conclusion: Brain abscess is a serious infection which must be diagnosed early and treated aggressively. Management of intracranial abscess should be individualized depending upon the various important factors like age of the patient, the level of consciousness at the time of admission, multiplicity of abscesses, the nature of the infection and plane and level of the abscess.

Key words: Brain abscess, Aspiration, Excision, Outcome

INTRODUCTION

Brain abscess is a focal infection, which begins when organisms are inoculated into the brain parenchyma, usually from a site distant from the central nervous system (CNS). Abscess formation occurs through several stages. Inflammation during the "early cerebritis" stage evolves into a necrotic collection of pus, eventually surrounded by a well-vascularized capsule after 2 weeks. [1, 2]

Although rare in developed countries, brain abscess is a serious, life-threatening emergency. Once having a dire outcome, morbidity and mortality have decreased because of advances in diagnostic modalities, antibiotic regimens, and earlier surgical interventions. [3,4] However, changes in epidemiology, including new disease pathogens and predisposing factors, have renewed concern about the diagnosis and treatment of this condition.

The incidence of brain abscess varies from 8-10% of all intracranial space occupying lesions in the developing countries reported by Osenbach, Loftus [5] and Sharma. [6] Intracranial abscess is still a significant health-care problem in developing countries. [7,8,9] Though potentially curable, brain abscess remains a diagnostic and therapeutic challenge. [6] The post CT scan era there are major advances in the diagnosis and management of brain abscesses, with a corresponding improvement in the survival rate in developed countries.[10] With the advancement in technology and development of stereotactic endoscopic technique in the treatment of brain abscess the mortality and morbidity are very low. [11,12] But these facilities are far from the reach in poor and developing countries and the mortality and morbidity is still high in under developed countries. Most of the reports from India are from later half of the 20th century. [9,13,14,15] These reports mainly deal with the bacteriology of brain abscesses. In some, the demography also has been discussed. The aim of this study was to analyse the current epidemiological picture of brain abscesses. The data were then compared with the available literature.

METHODOLOGY

A case series study of ten patients with intracranial abscess was studied. This study was done in the hospital setting in patients with intracranial abscess coming to neurosurgery department at Vijayanagara Institute of Medical Sciences, Bellary, from Janurary 2010 to December 2010. Ethical approval for the study was obtained from the Vijayanagara Institute of Medical College Ethical Review Committee (ERC). Departmental clearances were obtained and informed consent of the patient's immediate relatives was obtained. Among the selected patients the socio-demographic profile, clinical profile and the surgical interventions undertaken and the outcome were noted. CT scan confirmed diagnosed cases of intracranial abscess irrespective of their age and sex were included in the study and those cases who had a fungal, amoebic or tuberculosis brain abscess and patients who got discharged against medical advice were excluded from the study. Statistical analysis was performed using Epi Info Version 3.4.3. Appropriate descriptive statistics were used to analyse the findings and to draw the inferences. Statistical tests of significance, like chi-square (with corrections) were used wherever required.

RESULTS

Table: 01

Socio-demographic profile of cases			
socio-demographic variables		frequency	percentage
Age	< 10 years	2	20%
	10 - 20 years	2	20%
	21 - 30 years	5	50%
	> 30 years	1	10%
Gender	Male	6	60%
	Female	4	40%
Religion	Hindu	9	90%
	Muslim	1	10%
Region	Rural	9	90%
	Urban	1	10%
Occupation	Daily wage worker	5	50%
	Business	2	20%
	Student	2	20%
	Child	1	10%
Socio-economic status	BPL card holder	8	80%
	Non BPL card holders	2	20%

About 50% of the cases were in the age group of 21-30 years, the mean age of occurrence of intracranial abscess was 19.5 ±9.1 years (range being from 6 years to 32 years). A preponderance of males over females (6 : 4) was found amongst the patients . Majority of the cases were from Hindu religion (90%) and most of the cases were hailing from rural areas (90%) with a low socio-economic status (80%). About half of the cases were daily wage workers.

Table: 02

Clinical profile of cases			
Findings		frequency	percentage
Clinical features*	Headache	10	10%
	Vomiting	8	80%
	Fever	7	70%
	Seizures	3	30%
	Proptosis	2	20%
	Hydrocephalus	2	20%
	Papilloedema	6	60%
	Neck rigidity	1	10%
	Hemiparesis	1	10%
Glasgow coma scale	E2V2M5(moderate)	1	10%
	E3V2M5(moderate)	1	10%
	E3V3M5(moderate)	1	10%
	E3V4M5(moderate)	2	20%
	E4V5M6(Normal)	5	50%
Pre-existing illness*	CSOM	7	70%
	Sinusitis	3	30%
	Diabetes Milletus	2	20%
	Allergic rhinitis	1	10%
	Mucor mycosis	1	10%
Source of infection	Otogenic	7	70%
	Sinusitic	3	30%
Duration illness	upto 20 days	2	20%
	21 - 40 days	5	50%
	more than 40 days	3	30%
Number of days lost before admission	< 10 days	1	10%
	10-20 days	2	20%
	21-30 days	6	60%
	> 30 days	1	10%

*Multiple answers

The mean duration of illness at the time of presentation was 32.7±13.5 days (range 15 days to 60 days). The predominant symptoms of the cases were headache (100%), vomiting (80%) followed by fever (70%). However the classical triad of brain abscess headache, fever and focal neurological deficit was seen in only one case. Papillary edema was seen in 6 patients suggesting raised intracranial pressure and seizures was present in 3 patients. Apart from these common symptoms there were some uncommon symptoms like proptosis was observed in 2 patients and ptosis was seen in one patient. Other symptoms included hydrocephalus and neck rigidity (Table 2)

In this study the period between the onset of symptoms and admission varied from 9 to 45 days with mean of 25±9.2 days which reflects the health seeking behaviour of the patients. Half of the patients had a GCS score of 9-12 indicating moderate brain injury and rest of the patients had mild brain injury with GCS score of more than 13. The presence of a predisposing factor precipitating the onset of brain abscess was found in 90% of the patients in the present study. Chronic suppurative otitis media (CSOM) (70 %) was found to be the most important source of intracranial suppuration followed by sinusitis (30%). One of the patient was diabetic (Type II) who had paranasal sinusitis with allergic rhinitis with invasive mucor mycosis and one of the 12 year old student had insulin dependent diabetes mellitus.

Table: 03

CT scan findings			
Findings		frequency	percentage
Plane of abscess			
	Epidural	3	30%
	Subdural	1	10%
	Intracerebral	6	60%
Level of abscess			
Supratentorial			
	left hemisphere	6	60%
	right hemisphere	1	10%
	both hemisphere	1	10%
Infratentorial		2	20%
Multiplicity of abscess			
	Solitary	9	90%
	Multiple	1	10%
Size of abscess*			
	< 2 cm	2	20%
	2-5 cm	8	80%
	> 5 cm	1	10%

*multiple answers

Cerebral imaging was done by computerized tomography in all the cases. In 6 patients the plane of abscess location was intracerebral (60%) followed by epidural 3(30%) and subdural1 (10%). In 8(80%) of the patients the level of abscess location was supratentorial where abscess was present in the left side in 6 (60%) of the patients, on the right side in 1(10%) and bilateral in 1(10%). All of the patients had a solitary abscess except for one patient who had multiple abscesses. The mean size of abscess was 3.71±1.08 centimetres in diameter where the smallest abscess was measuring 1cm and the largest abscess being 5.4 cms in diameter. Midline shift was seen in one patient.

Table: 04

Management of Intracranial abscess				
Modality of treatment	aspiration only n(%)	aspiration followed by secondary excision n(%)	primary excision n(%)	conservative treatment n(%)
Plane of abscess				
Intracerebral abscess (n=6)	1 (16.6%)	4 (66.7%)	0 (0%)	1 (16.6%)
Intracranial epidural abscess (n=3)	0 (0%)	1 (33.3%)	2 (66.7%)	0 (0%)
Intracranial subdural abscess (n=1)	0 (0%)	0 (0%)	1(100%)	0 (0%)
Size of abscess				
less than 2 cms (n=1)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
morethan 2 cms (n=9)	1 (11.1%)	5 (55.6%)	3 (33.3%)	0 (0%)

All patients with intracerebral abscess with a diameter of more than 2 cms were managed first by aspiration to reduce the mass effect and later secondary excision was done in case of recurrence. But in cases of intracranial epidural abscess and subdural abscess primary excision was done. However abscess less than 2 cms was managed conservatively using antiboitcs.

Table: 05

Management of Intracranial abscess			
Mode of therapy	frequency	complication	mortality
Aspiration only	1	nil	nil
Antibiotics only	1	1	nil
Secondary excision	5	1	nil
Primary excision	3	nil	nil

In our study there was no mortality, however there were complications like transient upper motor neuron facial palsy in one patient with supratentorial parietotemporal solitary abscess measuring 4.7cms who required aspiration for 3 times and later underwent secondary excision and in another patient there was loss of vision who had left eye medial orbital space occupying lesion and was treated conservatively.

Table: 06

		Outcome		
Variables		uneventful	recurrence/complication	P value
Age	< 20 years (n=4)	2(50%)	2(50%)	
	> 20 years (n=6)	5(83.3%)	1(16.7%)	P=0.333*
Sex	Male (n=6)	3(50%)	3(50%)	
	Female (n=4)	4(100%)	0(0%)	P=0.166*
Treatment	Primary excision (n=3)	3(100%)	0(0%)	
	Secondary excision (n=5)	4(80%)	1(20%)	
	Aspiration only (n=1)	1(100%)	0(0%)	
	Conservative (n=1)	0(0%)	1(100%)	P=0.171*
Level of Consiousness	Moderate(n=5)			
	GCS: 9-12	3(60%)	2(40%)	
	Mild (n=5)			
	GCS: > 13	4(80%)	1(20%)	P=0.5*
Abscess location	Infratentorial (n=2)	2(100%)	0(0%)	
	Supratentorial (n=8)	5(62.5%)	3(37.5%)	P=0.466*
Source of infection	Otogenic (n=7)	5(71.4%)	2(28.6%)	
	Sinusitic (n=3)	2(66.6%)	1(33.3%)	P=0.716*

*Fisher exact test done

Patients who were treated by excision had a better outcome without any recurrence and complication when compared to patients who underwent aspiration and conservative methods. One of the patients who were managed conservatively met with a complication of loss of vision who had also a space occupying lesion in the left orbit. However there was no statistically significant difference in the outcome of

patient with respect to variables like age, sex, level of consciousness, surgical procedure done, abscess location and source of infection.

DISCUSSION

Approximately 1500-2000 new cases of brain abscess are diagnosed annually. In some underdeveloped countries, brain abscess accounts for 8% or more of all intracranial space occupying lesions, a sharp contrast to most developed nations where brain abscess constitutes only around 2% of all intracranial lesions. [16] In the present study we noticed that brain abscess could occur at any age. The mean age of occurrence of intracranial abscess was 19.5 ±9.1 years (range being from 6 years to 32 years). The most affected age group was 21–30 years. However, S Menon et al [17] (2008) found that most affected age group was 11–20 years. McClelland et al [18] (1978) found that this disease occurs most often in the middle decades of life. Sinha et al [9] (2003) reported 74.89% of their patients were below 20 years of age and similarly Mohammad quasim et al [19] (2008) found that the mean age of occurrence was 12.6 + 9.7 which is comparable to our study. Brain abscess is uncommon below the age of 2 years, but however there are occasional reports of brain abscess in infants documented in the literature. [20,21] A preponderance of males over females (6 : 4) was found amongst the patients in the present study. Similar observations have been reported in studies from different parts of world. [9,10,17,18,22] It is clear from all these studies that males are more vulnerable to brain abscess irrespective of the geographical region for reasons that remain unclear. Majority of the cases were from Hindu religion (90%) and most of the cases were hailing from rural areas (90%) with a low socio-economic status (80%). About half of the cases were daily wage workers indicating that brain abscess is more common among poor lower socio-economic status.

In the present study headache, fever, and vomiting made an important triad of symptoms which were present in 50% of patients. The predominant symptoms of the cases were headache (100%), vomiting (80%) followed by fever (70%). However the classical triad of brain abscess i.e headache, fever and focal neurological deficit was seen in only one case. Fever has been reported as the important presenting symptom in brain abscess patients by many workers; however, the absence of fever does not exclude the diagnosis and moreover no particular constellation of symptoms or signs is pathognomonic for brain abscess. Therefore the classic triad of headache, fever and neurological deficit cannot be used as a sensitive marker for the diagnosis of brain abscess. A similar finding has been reported by Ni et al [23] (2004). Papilloedema is another common sign suggestive of raised intracranial pressure which was present in 6(60%) cases. An alteration in the level of consciousness is usually present in up to two-thirds of the patients. [24,25] In the present study 30% of the patients were brought to the hospital with a Glasgow coma scale score less than 10. The state of consciousness of the patient at the time of admission is usually taken as a reliable prognostic marker.

All patients had a demonstrable infectious source leading to the intracranial suppuration. CSOM was found to be the major source of infection (Table 2). In most large series of brain abscesses from developing countries, middle ear infection has been reported to be the commonest source of intracranial suppuration. This has been reflected in various studies from India [9,14,15,17] and Pakistan. [19] This clearly indicates that in developing countries

particularly people from rural areas, belonging lower socio-economic status have poor health seeking behaviour and thereby often neglect an ear infection and not get treated aggressively, while in developed countries the incidence of complication of CSOM has come down to 0.04% of all cases of suppurative ear disease. [26] In our study we also noticed that otogenic abscesses are usually solitary and located commonly either in the temporal lobe or posterior fossa area. Similar reports have appeared in the literature. [27,28]

The brain lobe affected usually depends on the predisposing factor that led to the development of the brain abscess. In our study, the most common lobe involved was the temporal lobe because CSOM was found to be the major predisposing factor (Table 2). We found that 71.4% of the otogenic abscesses were in the temporal lobe. Similar observations have been reported by others. [9,10,14,17]

Under the cover of appropriate antibiotics all patients with intracerebral abscess (6 cases) with a diameter of more than 2 cms were managed first by aspiration to reduce the mass effect and later secondary excision was done in case of recurrence. But in cases of intracranial epidural abscess and subdural abscess primary excision was done. However abscess less than 2 cms was managed conservatively using antiboitcs. A similar approach was adopted by Muhammad Qasim et al, [19] 2010; Basit et al, [29] 1989; Malik et al, [30] 1994; Atiq Mehnaz et al, [31] 2006; where therapy was most often a combination of surgical aspiration with or without excision in addition to antimicrobial therapy.

The management of brain abscess has changed over the past 20-30 years. Cerebral abscess was once considered strictly a surgical disease that demanded urgent surgical intervention. However, given the ability to establish the diagnosis earlier using CT and/or MRI, along with the development of newer more effective antibiotics, there has been a trend toward non-operative management in selected patients. [11,32,33] The fact is, there are no prospective randomised trials on the treatment of brain abscess and there is no consensus regarding ideal management. Consequently, the optimal management of brain abscess remains a subject of controversy.

The empirical antimicrobial regimens commonly recommended for therapy of brain abscess vary from unit to unit. The basis for selecting the antibiotics is usually the site of the lesion and the suspected causative organism had been presumed based on previous scientific data. We used an empherical antimicrobial regimen consisting of ceftriaxone, amikacin and metronidazole in all cases.

Mortality ranging from 8 to 53% has been reported in other studies. Various factors contribute to mortality, the important factors being the age of the patient, the level of consciousness at the time of admission, multiplicity of abscesses and the nature of the infection. In our study there was no mortality, however there were complications like transient upper motor neuron facial palsy in one patient with supratentorial, parietotemporal solitary abscess measuring 4.7cms who required aspiration for 3 times and later underwent secondary excision and in another patient there was loss of vision who had left eye medial orbital space occupying lesion and was treated conservatively. Sarala Menon et al. [17] (2008) observed 9.5% mortality, and a statistically significant association was shown between the age of the patient and mortality and however Beller et al. [22] (1973) could not find a significant correlation between the age of the patient and mortality in their study. The level of consciousness at presentation has been

shown by other authors to be of great prognostic value. [18,34]

CONCLUSION

Brain abscess is a serious infection which must be diagnosed early and treated aggressively. In majority of the cases of intracranial abscess are associated with common predisposing factors like CSOM, sinusitis and others. headache, fever, and vomiting made an important triad of symptoms which is commonly present in more than half of the patients. Management of intracranial abscess should be individualized depending upon the various important factors like age of the patient, the level of consciousness at the time of admission, multiplicity of abscesses, the nature of the infection and plane and level of the abscess.

REFERENCES

1. Lu CH, Chang WN, Lui CC. Strategies for the management of bacterial brain abscess. *J Clin Neurosci*. Dec 2006;13(10):979-85 . [Medline].
2. Mathisen GE, Johnson JP. Brain abscess. *Clin Infect Dis*. Oct 1997;25(4):763-79; quiz 780-1. [Medline]
3. Alderson D, Strong AJ, Ingham HR, et al. Fifteen-year review of the mortality of brain abscess. *Neurosurgery*. Jan 1981;8(1):1-6. [Medline]
4. Carpenter J, Stapleton S, Holliman R. Retrospective analysis of 49 cases of brain abscess and review of the literature. *Eur J Clin Microbiol Infect Dis*. Jan 2007;26(1):1-11. [Medline]
5. Osenbach RK, Loftus CM. Diagnosis and management of brain abscess. Neurosurg Clin N Am 1992;3:403-20.
6. Sharma BS, Gupta SK, Khosla VK. Current concepts in the management of pyogenic brain abscess. Neurol India 2000;48:105-11).
7. Kao, P.T., Tseng, H.K., Liu, C.P., Su, S. C. & Lee, C.M. (2003). Brain abscess: clinical analysis of 53 cases. J Microbiol Immunol Infect 36, 129–136.
8. Seneviratne, R. S., Navasivaym, P., Perera, S. & Wickremasinghe, R. S. (2003). Microbiology of cerebral abscess at the neurosurgical unit of the National Hospital of Sri Lanka. Ceylon Med J 48, 14–15.
9. Sinha, A. K., Mohanty, S., Sharma, V., Choudhury, A., Huda, M. F., Singh, V. P. & Tiwari, Y. A. (2003). A study of 268 consecutive cases of intracranial suppuration. Neurosciences Today 7, 161–165.
10. Bhand, A. A. (2004). Brain abscess – diagnosis & management. J Coll Physicians Surg Pak 14, 407–410.
11.Rosenblum ML, Mampalam T, Pons V. Controversies in the brain abscess management. Clin Neurosurg 1986;33: 603-32.
12. Duma CM, Kondziolka D, Lunsford LD. Image guided stereotactic treatment of non-AIDS-related cerebral infection. Neurosurg Clin N Am 1992;3:291-302.
13. Chandramuki, A., Hegde, A. S. & Reddy, N. (1980). Anaerobic brain abscess – role of metronidazole in chemotherapy. Neurol India 28, 213–218.
14. Bharadwaj, R. & Joshi, B. N. (1988). Brain abscesses – a study of the causative organisms with special reference to anaerobes. Indian J Pathol Microbiol 31, 44–48.
15. Lakshmi, V., Rao, R. R. & Dinkar, I. (1993). Bacteriology of brain abscess – observation on 50 cases. J Med Microbiol 38, 187–190.
16. Gormley W, Rosenblum M. Cerebral abscess. In: Tindall G, Cooper P, Barrow D (eds). The Practice of Neurosurgery. Philadelphia: Lippincott Williams and Wilkins; 1996:3343-54

17. Sarala Menon, Renu Bharadwaj, Abhay Chowdhary, D. V. Kaundinya and D. A. Palande (2008). Current epidemiology of intracranial abscesses: a prospective 5 year study; Journal of Medical Microbiology (2008), 57, 1259–1268

18. McClelland, C. J., Craig, B. F. & Crockard, H. A. (1978). Brain abscess in Northern Ireland: a 30-year community review. J eurol Neurosurg Psychiatry 41, 1043–1047.

19. Muhammad Qasim, Mohammad Naeem ur Razaq, Mohammad Saddiqe, Mohammad Ilyas, Azmatullah Khattak Management Of Supratentorial Brain Abscess. JPMI 2010 VOL.24 NO.02:91-94

20. Erdogan, E., Izci, Y., Dizer, U. & Baysefer, A. (2002). Multiple brain abscesses in a baby: case report and review of the literature. Ann Neurosurg 2, 1–6.

21. Han, S., Lim, D. J., Chung, Y. G., Cho, T. H., Lim, S. J., Kim, W. J., Park, J. Y. & Suh, J. K. (2002). The multiple brain abscesses associated with congenital pulmonary arterovenous malformations: a case report. J Korean Med Sci 17, 407–411.

22. Beller, A. J., Sahar, A. & Praiss, I. (1973). Brain abscess – review of 89 cases over a period of 30 years. JNeurol Neurosurg Psychiatry 36, 757–768.

23. Ni, Y. H., Yeh, K. M., Peng, M. Y., Chou, Y. Y. & Chang, F. Y. (2004). Community-acquired brain abscess in Taiwan: etiology and probable source of infection. J Microbiol Immunol Infect 37, 231–235.

24. Morgan, H., Wood, M. & Murphy, F. (1973). Experience with 88 consecutive cases of brain abscess. J Neurosurg 38, 698–704.

25. Mampalam, T. J. & Rosenblum, M. L. (1988). Trends in the management of bacterial brain abscess: a review of 102 cases over 17 years. Neurosurgery 23, 451–457.

26. Osma, U., Cureoglu, S. & Hosoglu, S. (2000). The complications of chronic otitis media: report of 93 cases. J Laryngol Otol 114, 97–100.

27. Samson, D. S. & Clark, K. (1973). A current review of brain abscess.Am J Med 54, 201–210.

28. Carey, M. E., Shelley, N., Chou, S. N. & French, L. A. (1972). Experience with brain abscesses. J Neurosurg 36, 1–9.

29. Ali Syed Basit, Bhatia Ravi, A K Banerji, P N Tandon. (1989). Multiple pyogenic brain abscesses: an analysis of 21 patients. *Journal ofNeurology, Neurosurgery, and Psychiatry* 1989; 52:591-594

30. S Malik, S M Joshi, P W Kandoth, U S Vengsarkar. Experience with brain abscesses. *Indian Journal of Paediatrics* 1994; 31: 661-666

31. Atiq Mehnaz, Ahmed Umair Syed, Allana Salman Saleem, Chishti N Khalid (2006).
Clinical features and outcome of cerebral abscess in congenital heart disease. *J Ayub Med Coll Abbottabad* 2006;18(2): 21-24

32. Heinemann HS, Braude AI. Intracranial suppurative disease. *JAMA* 1971; 218: 1542-7

33. Rousseaux M, Lesoin F, Destee A, et al. Developments in the treatment and prognosis of multiple cerebral abscesses. *Neurosurgery* 1985;64: 304-8

34. Karandanis, D. & Shulman, J. A. (1975). Factors associated with mortality in brain abscess. Arch Intern Med 135, 1145–1150.

****