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Microbiological Profile of Brain Abscess

S K Das*, Divye Prakash Tiwari*, Vivek Sharma*, Gopal Nath**
*Department of Neurosurgery and **Microbiology Institute of Medical Sciences BHU, Varanasi, India

Abstract

Objective: The objective of the study was to review the microorganisms found in the brain abscess.

Methods We evaluated 104 patients of brain abscess admitted at our university hospital. Apart from routine hematological investigations and chest X-ray, all patients were subjected to CT scan or MRI study. Skiagram Skull, CSF study, Ultrasonography of head through open fontanelle in infants and in patients with cranial defects and special tests for Tuberculosis, HIV were done accordingly. Microbiological evaluation of the isolate was done in all cases. Preoperative and postoperative neurological function was assessed.

Observations Pus culture was positive in 54.56 percent of cases. Anaerobic organism was found in 5.77 percent while mycobacterium in 3.85 percent, fungi in 1.92 percent. Streptococcus was the commonest offending organism followed by Staphylococcus and Pseudomonas. Pseudomonas was most resistant organism.

Conclusion Chronic suppurative otitis media is still a major cause of brain abscess in developing country like India, which is a benign and curable disease and should not be neglected. Streptococcus was the commonest offending organism see. Unless anaerobic cultures are done, anaerobic organisms as causative agents can be easily missed. With the advent of newer and exotic diseases the culture spectrum of brain abscess is bound to change.

Key words Brain abscess, subdural abscess, cerebral abscess, cerebellar abscess, chronic suppurative otitis media, bacteria, fungal culture

Introduction

The incidence of brain abscess depends on geographic location and living standards within a given region. The incidence is higher in underdeveloped countries where living conditions remain poor. A brain abscess is initiated when microorganisms are introduced into cerebral tissue. Most infective agents gain access to the central nervous system either directly or via hematogenous spread [1]. Although the source of infection is frequently apparent, the definitive cause remains obscure in 10-37 percent of patient [2]. Approximately 80 percent of patient with a brain abscess have a known predisposing factor, while the

Address for correspondence and reprint requests to: Dr. Divye Prakash Tiwari 175/4 Kalinga Colony, Araghar, Hardwar Road, Dehradun-248001 Uttanchal, India
Email kamlatiwari7@gmail.com
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remaining 20 percent are cryptogenic [3]. Brain abscess is a focal suppurative process of the brain parenchyma caused by a spectrum of microbes. The finding of sterile brain abscess was a serious diagnostic dilemma to the neurosurgeon until Ingham et al (1977) introduced the routine anaerobic culture technique with anaerobic organisms as causative factors [4]. The microbiological profile of brain abscess has changed in the past 50 years. In the pre-antibiotic era, bacteriological analysis revealed that S. aureus was causative organism in 25 to 30 percent of cases, *Streptococci* in 30 percent, coliform in 12 percent and no growth in over 50 percent [5].The most common anaerobic isolates from brain abscess include the *Bacteroid spp*. (*B. fragilis* and *B. melanogenicus*) and the anaerobic *Streptococci* (*Peptosteptococcus*). Aerobic bacteria most frequently associated with brain abscess include *staphylococcus spp*., *streptococcus spp*., *enterobacteriaceae* and *hemophilus spp* [6]. Uncommon pathogens can also cause brain abscess in an immunocompromised state. These are *Listeria monocytogenes, mycobacterium, Toxoplasma gonddi, Candida spp., Cryptococcus, Nocardia, Strongyloides stercoralis* and *N. asteroides*. The bacteriological profile found within an abscess is closely linked to the etiology of the infection. Although most abscesses are caused by a single organism, mixed infections occur in up to 33 percent of cases and are especially common in otogenic infection. Kagawa et al (1983), in a review of 62 cases of brain abscess with cyanotic heart disease also found *streptococcus* as the commonest organism [7]. Levy et al (1985) noted that *Toxoplasma gondii* in the most common non viral CNS infection in AIDS [8]. Hartman et al (2000) reported a case of intracerebral abscess caused by *Nocardia* in a renal transplant patient [9]. The bacteriology of brain abscess differs in neonates and infants. Brain abscess in this population is caused almost exclusively by *Proteus spp*. and *Citrobacter spp*... Renier et al (1988) reviewed 30 cases of neonatal brain abscess and found that 90 percent of the abscesses were caused by Proteus spp. [10]

Methods

Apart from routine hematological investigations and chest X-ray, all patients were subjected to CT scan or MRI study. X-ray Skull, CSF study, Ultrasonography of head through open fontanelle in infants and in patients with cranial defects and special tests for Tuberculosis, HIV were done according to need. All patients were managed either conservatively or by aspiration (by twist drill, USG guided or stereotactic) or by surgical excision. Pus was sent for slide examination (gram staining, Z-N staining for AFB, Indian ink staining), and culture and sensitivity test (Aerobes, Anaerobes, AFB, Fungus). Abscess wall was also sent for histopathological examination. Third generation cephalosporin and metronidazole were given in all patient emperically which were subsequently changed after culture and sensitivity report.

Treatment for primary focus was also advocated as per direction of concerned department. All patients were followed up for at least three months and observed for recurrence and neurological sequelae. All the relevant data were collected and analysed.

Observations

Out of a total of 104 patients, 79 were male and 25 were female, thus male and female ratio was 3.16:1. Majority of the patients were below 20 years of age. There were 76 cases (73.08%) below the age of 20 years. Youngest patient was of 2 months of age and the oldest was 63 years old. Chronic suppurative otitis media was the commonest source of infection. A total of 57 cases i.e. 54.81% developed brain abscess secondary to discharging ear. The eight of them were having bilateral ear discharge. The duration of ear discharge was from few months to many years. One

of them had an abscess contralateral to the ear discharge. In 10 cases, hematogenous spread of infection from remote area was the cause of brain abscess. Cyanotic heart disease was etiological factor in four cases. In one case the source of infection was dental caries. Two cases were associated with HIV infection, among which one case was of fungal origin. Trauma was detected as the cause in 11 cases. Two of them were having traumatic CSF rhinorrhea where abscess was located in frontal lobe. We had one unusual case of brain abscess where infected dermoid was probed by wooden stick which accidentally went inside the brain because skull bone was eroded by dermoid. Meningitis was associated in 3 cases; one of them of paediatric age group presented with subdural empyema along with parenchymal abscess. No source was identified in 23 cases and none of abscess developed following paranasal sinus infection. Two of our cases were having deficiency in cell mediated immunity (HIV). Two cases were found following surgery for head trauma in the post op period. The Empyema thoracic was the cause of abscess in one case. Those cases having illness for less than one month were kept in one group while those having illness of more than one month were kept in other group. Eighty two (79%) patients presented with duration of illness for less than one month. Majority of cases (88%) reported between 15 to 35 days duration of illness i.e. in the stage of late capsule formation and thus having well defined capsule. At presentation, 85 patients (81.73%) were having symptoms suggestive of raised intracranial pressure i.e. headache and vomiting. Eighty six cases (82.25%) suffered from headache which was continuous and throbbing in nature. Sixty five patients (62.65%) had vomiting or nausea. There was mild to moderate degree of fever in 61 cases (58.72%) and 21 cases (20%) presented with seizure whether focal or generalized. Thirty Four patients had altered state of sensorium ranging from drowsiness to deep coma. Patients of paediatric age group with multiple boil or pulmonary infections presented as meningitis and were initially admitted in paediatric medicine ward before being referred to neurosurgical unit. Interestingly, one of our patients presented with an enlarging head and was referred to us as a case of hydrocephalus. Thirty three cases (31.80%) had focal neurological deficit in the form of hemiparesis, cranial nerve weakness, dysphasia, and cerebellar signs. Eighteen cases (17%) had hemiparesis with mild weakness of 7^{th} cranial nerves in few cases. Seven cases presented with difficulty in speech in the form of sensory dysphasia or pure nominal aphasia. Ataxic gait and ipsilateral cerebellar signs were present in 18% of cases. Fifty patients (48%) were found to have papilloedema suggestive of raised intracranial pressure. There was pupillary abnormality in 11 cases. All the patients were grouped according to their GCS, 7.69% of patients had GCS less than 9, while 25.96% had GCS between 9 to 12 and 66.35% of patients were between GCS 13 to 15. There is significant association between category of GCS and mortality with p value 0.000. For fisher's exact test (exact p value) <0.000 was considered significant and for person chi-squere test <0.000 was consider significant. Temporal, temporoparietal and cerebellum were the commonest site of abscess. Temporal lobe was the site in 27 cases (25.96%) with or without extension to parietal lobe. Whereas cerebellum was involved in 16.35% of cases. Twenty one patients had frontal abscess and thirteen had frontoparietal location. Multiple abscesses were found in 8 cases and kept in separate group irrespective of intracranial location. Two patients had thalamic abscess.Six cases (5.77%) were associated with either subdural empyema or epidural abscess. In two cases, interhemispheric subdural abscess was found along with temporal abscess which was hematogenous in origin. Rest of subdural/ epidural abscesses were associated with otogenic

Table 1 : Causative Organisms

Nature of isolate	Nature of isolate	No. of cases	No. of isolates
Pyogenic		51	**49.04**
Aerobes	**43**		**41.34**
	Streptococci	19	**18.27**
	Staphylococci	10	**9.61**
	Pseudomonas	3	**2.88**
	Proteus	2	**1.92**
	E. Coli	2	**1.92**
	Citrobactor	2	**1.92**
	Kleibseilla	1	**.96**
	Mixed	4	**3.85**
Anaerobes	**6**		**5.77**
	Bacteroides	4	**3.85**
	Peptosteptococcus	1	**.96**
	Fusobacterium	1	**.96**
Aerobes + Anaerobes		2	**1.92**
Mycobacteria		4	**3.85**
Fungi	Aspergillus, Candida	2	**1.92**
No organism isolated		**47**	**45.44%**

abscess. Out of 57 cases of otogenic origin, 31 cases (53.71%) were located supratentorially and 26 cases (46.29%) were infratentorially. In hematogenous group only one case was found in cerebellum out of 10 cases. In cyptogenic group, eighteen (78.28%) were located supratentorially and five (21.72%) were infratentorially. In both hemaetogenous and cryptogenic groups, the supratentorial and infratentorial variables were significantly different in there prevalence with p value of 0.0003 and 0.0001 respectively. Out of 104 cases, only ninety two were studied after CT scan and on the basis of CT finding, they were grouped either in cerebritis stage or in capsular stage. There was well defined ring lesion i.e. capsular stage of abscess formation in 99 cases (95.62%) as most of the cases had duration of illness more than 15 days. Both groups were significantly different in their prevalence with p value of 0.000. Eighty two (78.45%) cases had mass effect and midline shift on radiological examination.

Microbiological Examination

Pus culture was positive in only 57 cases (54.56%). *Streptococcus* was the commonest offending organism seen in 21 cases followed by *staphylococcus* (n = 13) and *pseudomonas* (n = 3). Most resistant organism was *pseudomonas* having two recurrences. Culture was sterile in 47 cases (45.44). Anaerobes were found in 6 cases (5.77%) where bacteroides species was the principal isolates. In 9 cases (8.65%) mixed organisms were found. *Mycobacterium* was isolated in 4 cases out of which 2 cases were associated with pulmonary kochs. Within 2 fungi cases, *candida* was associated with HIV infection. [Table 1]

Management

Since most of the cases presented in early and late capsular stage according to CT scan, managed directly by excision of abscess cavity. Seventy Eight cases (75.00%) were managed by direct excision. Nine cases (8.65%) were managed by preliminary aspiration followed by excision because of deteriorating consciousness. Twelve cases (11.54%) were

managed only by repeated aspiration. Conservative treatment was given to the abscess in cerebritis stage and small solitary abscess. Two cases of cerebritis stage were subjected to operation when showed sign of deterioration on conservative treatment. The entire cerebellar abscess was managed by surgical excision. Multiloculated abscess was also treated by direct surgical excision. Multiple abscesses were treated conservatively. All the cases, irrespective of surgical procedure, received antibiotics either single or in combination. During last 5 to 6 year, a combination of ceftriaxone and metronidazole were started in every case and changed subsequently after culture report. Those cases showing sterile culture showed good response to both drugs. Those cases which were managed conservatively, received antibiotics for 4-6 weeks including 2 weeks of intravenous therapy while those cases which were treated by direct excision, received antibiotics only for 3 weeks.

Outcome

Overall mortality in this series was 10.58%. Patient with cyanotic heart disease and those having multiple abscesses had the highest mortality. Those patients who were having low GCS and features of herniation died even after surgery. Those cases having GCS below 8 had 62.50% mortality, while mortality was only 1.45% in the patient having GCS between 13 to 15. Four cases which were being treated by repeated aspiration died and one died who was put on conservative treatment. Three patients died among direct surgical excision group.

There were 5 cases of recurrence, three of them were those who did not go for operation for otitis media i.e. eradication of primary focus and two recurrent cases were those who were infected by pseudomonas and had aspiration only. All patients received antiepileptic drug [AED] post-operatively and only two cases had generalized seizure in spite of AED. All the patients presented with focal neurological deficit improved completely either during post operative hospital stay or follow up period, except solitary case of pyocephalus who remained in vegetative state till one year of follow up.

Discussion

The microbiological profile of brain abscess has changed in the past 50 years. In the pre-antibiotic era, bacteriological analysis revealed that *Staph. aureus* was causative organism in 25 to 30 percent of cases, *streptococci* in 30 percent, coliforms in 12 percent and no growth in over 50 percent of cases.[11] The most common organism reported have been *Streptococci, Staphylococci* and Anaerobic organism.[12-14]

More recent series have shown increased incidence of brain abscess caused by anaerobic organism. [15] In our series *Streptococci* and *Staphylocci* was the commonest organism isolated and also significant numbers of *Pseudomonas* was isolated. Upon reviewing the literature the overall incidence of *Pseudomonas* as the causative organism has been found to be low. Pit et al (1993) and Gupta et al (1990) found pseudomonas as causative organism in otogenic cases [16, 17]. In our series *Pseudomonas* cases were found mostly in otogenic group. Multiple drug resistance was found to be the major problem in *Pseudomonas* infection leading to recurrence and mortality. Anaerobic brain abscesses are often associated with CSOM. In the present study, 12 out of 13 specimens containing anaerobes were associated with CSOM. Otogenic infection was found to be the most common source of infection for anaerobic brain abscesses reported in the various studies. Anaerobic Gram-negative bacilli belonging to the family *Bacteroids* were the predominant isolate reported from this group. The most common anaerobe isolated in this study was *B. fragilis*. For 47 (45.44%) specimens in this study, no

organism was isolated from culture. The high incidence of such cultures may be because the samples were collected from a tertiary care centre and patients had undergone a treatment of long duration with broad spectrum of antibiotics before they reported to the hospital. *Mycobacterium* was found in 4 cases (3.85%) of all brain abscess cases in our study. Out of which 2 cases (50%) were associated with pulmonary Koch's in contrast to 1 of 6 cases (16.67%) in Raj kumar et al's series (2002) [18]. The difference may be due to small sample in the study. Fungal abscess was found in 2 cases (1.92%); *Aspergillus* species was isolated from one of the HIV infected case which succumbed in long treatment.

Conclusion

The chronic suppurative otitis media is still a major cause of brain abscess in developing country like India which is a benign and curable disease and should not be neglected. Streptococcus was the commonest offending organism. Unless anaerobic cultures are done anaerobic organisms as causative agents can be easily missed. With the advent of newer and exotic diseases the culture spectrum of brain abscess is bound to change.

Conflict of Interests

The authors declare that there are no conflict of interests

Authors' Contribution

VS: Concept of study and final approval

DPT & SKD: Concept and analysis of study, literature search and preparation of manuscript

GN: Concept and design of study

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Ethical Considerations

The study was approved by the Institute Ethics Committee.

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